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VOL. CXLIII.—No. 3721] LONDON: FRIDAY EVENING, MAY 6, 1927 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

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PUBLIC NOTICES

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
About 680 TONS of STEEL FISH BOLTS.
Tenders due on the 20th May, 1927. Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 5427

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
1. COPPER FIRE-BOX PLATES for LOCOMOTIVES.
2. CRANK and STRAIGHT AXLES for LOCOMOTIVES.
3. 1302 TYRES for LOCOMOTIVES.
4. 400 PAIRS of DISC WHEELS and AXLES for WAGONS.
5. SOLID-DRAWN STEEL BOILER TUBES.
Tenders due on the 17th May, 1927, for Nos. 1 and 2, and on the 20th May, 1927, for Nos. 3, 4, and 5.
Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 5417

Assistant Engineer Re- QUIRED by the LAGOS TOWN COUNCIL, NIGERIA, for two tours of 12 to 18 months' service, with possible extension. Salary £480 a year for the first three years of service, then £510, rising to £720 a year by annual increments of £30. Free quarters and passages. Liberal leave on full salary. Outfit allowance of £60 on first appointment. Candidates, age 25 to 35, must have been trained in a Municipal Engineer's office, be good surveyors, and have had experience in drainage, road and bridge construction, town planning and other municipal works. Candidates who are A.M.I.C.E. will be given preference.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, mentioning this paper and quoting M/15350. 5419

Civil Engineers (2) Re- QUIRED for the PUBLIC WORKS DEPARTMENT of TANGANYIKA TERRITORY for a tour of 20 to 30 months' service, with possible extension. Salary £480, rising by annual increments to £720 a year (with efficiency bar at £600). Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 35, preferably unmarried, must have been regularly trained as civil engineers and be corporate members of the Institution of Civil Engineers. Must be capable of levelling, surveying, measuring up work and preparing designs of bridges, &c. Must have had at least three years' experience under a qualified civil engineer on the construction of Harbour Works, Drainage Works, Water Supply or other Public Works.—Apply at once by letter, stating age, qualifications, and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, mentioning this paper and quoting M/14402. 5352

Storekeeper Required for the GOVERNMENT RAILWAY of the FEDERATED MALAY STATES for four years' service, with prospect of permanency. Salary, dollars 325 a month, rising by dollars 10 a month to dollars 375 a month, plus a strictly temporary non-pensionable cost-of-living allowance of 10 per cent. of salary for bachelors and dollars 80 a month for married men. Officers of exceptional merit may eventually rise to a maximum salary of dollars 500 a month. A bonus of six months' salary is payable if employment ceases on the termination of the four years' service provided that the officer's work and conduct have been entirely satisfactory. The Government rate of exchange is now 2s. 4d. to the dollar, but the purchasing power of the dollar in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free second-class passages, subject to certain conditions, for wife and children also, not exceeding four persons beside the candidate selected. Candidates, aged 23 to 35, must have a practical knowledge of general stores commonly in use on railways, practical experience of stock keeping in stores warehouse, preferably railway, together with such knowledge of accounts and correspondence as is necessary for same.—Apply at once by letter, stating whether married or single, age, and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/15216. 5381

Armstrong College,
NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.SC. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
5089 Newcastle-upon-Tyne.

Crystal Palace School of Prac- TICAL ENGINEERING.
Founded 1872.
MECHANICAL AND CIVIL ENGINEERING DIVISIONS.
PRESIDENT: J. W. WILSON, M.I.C.E., M.I.M.E.
PRINCIPAL: MAURICE WILSON, M.I.C.E.
Assisted by Staff of Lecturers and Instructors.
Thorough, up-to-date Practical and Theoretical Instruction. Course completed in 2 years.
Students admitted at beginning of any term. 5159

Manchester Municipal College OF TECHNOLOGY.
PRINCIPAL:
B. MOUAT JONES, D.S.O., M.A. (Oxon).
UNIVERSITY OF MANCHESTER
(FACULTY OF TECHNOLOGY).
DEGREE COURSES IN TECHNOLOGY.

The Prospectus gives particulars of the Courses leading to the Manchester University Degrees (B.Sc. Tech., M.Sc. Tech., and Ph. D.) in the Faculty of Technology, in the following Departments :—
MECHANICAL ENGINEERING (Prof. Dempster Smith, M.B.E., M.Sc. Tech.).
ELECTRICAL ENGINEERING (Prof. Miles Walker, M.A., D.Sc.).
MUNICIPAL AND SANITARY ENGINEERING (G. S. Coleman, D.Sc.).
CHEMICAL TECHNOLOGY, including General Chemical Technology, Chemistry of Textiles (Bleaching, Dyeing, Printing and Finishing), Paper Manufacture, Metallurgy and Assaying, Chemical Technology of Brewing, Electro-Chemistry, Photography, Colouring Matters, Foodstuffs and Fuels (Prof. F. L. Pyman, D.Sc., F.R.S.).
TEXTILE TECHNOLOGY (Prof. W. B. Morton, M.Sc. Tech.).
Prospectus will be forwarded free on application to the REGISTRAR, College of Technology, Manchester. 5409

Ashborne Urban District COUNCIL.
RODSLEY WATER SCHEME.—CONTRACT NO. 5. CAST IRON PIPES.
The Council invite TENDERS for the MANUFACTURE and DELIVERY of about 300 TONS of CAST IRON REGULAR PIPES and SPECIALS of 7in. and 3in. diameter.
The pipes are to be made in accordance with the British Standard Specification.
Copies of the specification and form of Tender, prepared by the Engineer, Dr. Herbert Lapworth, M. Inst. C.E., 25, Victoria-street, Westminster, may be obtained on application to the Clerk to the Council. The application must be accompanied by the sum of £2, which will be refunded on return of the documents required.
Tenders are to be sent in on the form supplied, and with the specification must be enclosed in a sealed cover, endorsed "Rodsley Water Scheme; Tender for Cast Iron Pipes: Contract No. 5," addressed to and reaching the Clerk to the Council not later than 10 a.m. on Monday, May 16th.
The Council do not bind themselves to accept the lowest or any Tender.
R. WILLIAMS,
Clerk to the Council.
Council Offices,
Ashborne, Derbyshire. 5379

Ashborne Urban District COUNCIL.
RODSLEY WATER SCHEME.—CONTRACT NO. 6. PIPE LAYING.
The Council invite TENDERS from experienced contractors for the LAYING of about 3½ MILES of 7in. and 3in. CAST IRON PIPES and SPECIALS, together with VALVES, HYDRANTS, METERS, &c. The pipes will be supplied by the Council.
The work will extend from the New Pumping Station of the Council at Rodsley to the Service Reservoir in Derby-road, Ashborne, Derbyshire.
Copies of the specification and form of Tender, prepared by the Engineer, Dr. Herbert Lapworth, M. Inst. C.E., 25, Victoria-street, Westminster, may be obtained on application to the Clerk to the Council. The application must be accompanied by the sum of £3, which will be refunded on return of the documents within seven days or after receipt of a bona fide Tender and the documents required.
Tenders are to be sent in on the form supplied and with the specification must be enclosed in a sealed cover, endorsed "Rodsley Water Scheme: Tender for Pipe Laying: Contract No. 6," addressed to and reaching the Clerk to the Council not later than 10 a.m. on Monday, May 23rd.
Facilities for examining the drawings, for inspecting the site and general information may be obtained on application to Mr. D. Powell, M. Inst. M. and Cy. E., Surveyor to the Council, Council Offices, Ashborne, Derbyshire.
The Council do not bind themselves to accept the lowest or any Tender.
R. WILLIAMS,
Clerk to the Council.
Council Offices,
Ashborne, Derbyshire. 5378

County Borough of Burnley.
GAS DEPARTMENT.
OLD HALL WORKS.
TO THE MANUFACTURERS OF STEAM ACCUMULATOR OR ELECTRICALLY DRIVEN LOCOMOTIVES.
LOCOMOTIVE FOR THE HAULAGE OF HOT COKE.
TENDERS are INVITED for the CONSTRUCTION, SUPPLY, DELIVERY, and SETTING TO WORK of a suitable LOCOMOTIVE of the Steam Accumulator or Battery or Trolley Electrically Driven Type for the above scheme.
Specification, form of Tender, general conditions of contract, and copies of the layout plan may be obtained on application to the undersigned.
Sealed Tenders to be delivered at the Gasworks, Burnley, on or before the 14th May, 1927, addressed to the Chairman of the Gas Committee, and endorsed "Tender for Locomotive."
J. HERBERT CLEGG, F.C.S.,
Engineer and Manager.
Gasworks, Burnley,
30th April, 1927. 5382

The Institution of Structural ENGINEERS.
MODIFIED EXAMINATION FOR ASSOCIATE-MEMBERSHIP.
The next MODIFIED EXAMINATION for ASSOCIATE-MEMBERSHIP will be held on 21st MAY, and entries must be received by the 16th May. The Examination is for candidates having ten years' professional experience, and entries are subject to approval by the Board of Examiners. It should be noted that this Examination is liable to be permanently and finally closed by the Council at any time. It is intended only for those actually practising in the profession who have not the present time or opportunity to take the whole Examination. It is not intended for the ultimate use of present students, who should apply to sit for the ordinary Examinations.
Syllabus and full particulars from the undersigned,
MAURICE G. KIDDY, F.I.S.A.,
Secretary.
10, Upper Belgrave-street,
London, S.W. 1. 5374

Armourers & Brasiers' Company.
LECTURES IN METALLURGY.
The Company have arranged for the following Lectures to be delivered :—
At the Sir John Cass Technical Institute, 31, Jewry-street, Aldgate, E.C., at 6.30 p.m., on the 17th and 31st May and 14th June, 1927, by
W. H. HATFIELD, Esq., D.Sc.
(Director of Research, Brown-Firth Laboratory, Sheffield), on
Special Steels and their Application in Engineering.

At the Royal School of Mines, Prince Consort-road, South Kensington, S.W., at 5.30 p.m., on the 18th and 25th May and the 1st June, 1927, by
ULICK R. EVANS, Esq., M.A.,
on
Oxidation, Corrosion and Passivity of Metals.
ADMISSION FREE, WITHOUT TICKET. 5418

Belfast Harbour.
The Belfast Harbour Commissioners invite TENDERS for the ERECTION of an EXTENSION to the GOODS SHED on the West Side of Dufferin Dock, Belfast, in accordance with drawings which may be seen at the office of the Harbour Engineer, Mr. T. S. Gilbert, M. Inst. C.E., from whom copies of the specification of works, form of Tender, and any further information may be obtained.
Tenders on the special form provided for that purpose should be addressed to the undersigned and must be enclosed in a sealed envelope, endorsed "Tender for Extension of Goods Shed," and delivered not later than Wednesday, the 1st June, 1927.
The Commissioners do not bind themselves to accept the lowest or any Tender.
M. J. WATKINS,
General Manager and Secretary.
Harbour Office, Belfast,
28th April, 1927. 5384

County Borough of Halifax.
HALIFAX CORPORATION WATERWORKS.
GORPLE RESERVOIRS.
The Waterworks Committee are prepared to receive TENDERS for the CONSTRUCTION of EMBANKMENTS, &c., for the FORMATION of RESERVOIRS with Ancillary Works in the Gorple Valley, at a distance of about five miles from the Railway Stations of the London, Midland and Scottish Railway at Burnley, and Hebden Bridge respectively. The work will consist of the Excavation and Refilling of the Puddle Trenches, Earthwork Embankments, Waste Weirs, Watercourses, Discharge Tunnels, Valve Shafts and Pipe Lines, of various diameters, including Wells, Meter and Valve Houses, &c. Drawings can be seen and copies of the specification, schedule and form of Tender may be obtained at the offices of Messrs. G. H. Hill and Sons (Manchester), Civil Engineers, 40, Kennedy-street, Manchester, upon the receipt of cheque for Five Guineas. This sum will, after the Corporation shall have come to a decision upon the Tenders, be returned to those parties who shall have sent in a bona fide Tender, shall not have withdrawn the same, and shall have returned the documents and drawings lent to them for the purpose of making up their Tender. A limited number of sets of drawings (uncoloured) are available, and will be lent to persons tendering in priority of application on receipt of the sum of Three Guineas, which will not be returned. Sealed Tenders, endorsed "Tender for Gorple Reservoirs," must be forwarded to the Town Clerk, Town Hall, Halifax, on or before Monday, the 30th May, 1927. The Committee do not bind themselves to accept the lowest or any Tender.
PERCY SAUNDERS,
Town Clerk.
Town Hall, Halifax,
27th April, 1927. 5357

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PUBLIC NOTICES

Great Southern Railways

COMPANY.
CONTRACTS, 1927.

The Directors of the Great Southern Railways Company are prepared to receive TENDERS for the SUPPLY of the undermentioned STORES for six months, commencing 1st July, 1927, and alternatively for twelve months, commencing the same date :—

	No. of Form.
Ambulance Sets and Refills	43
Asbestos Sheeting, &c.	40
Axles, Steel, Crank, for Locos. and Tenders	101
Axles, Steel, Straight, for Locos. and Tenders	102
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Brass, Sheet, Wire, &c.	115
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Blooms, Steel, for Locos.	100
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Bolts, Fish	16
Brooms & Brushes	13
Cables, Electric	129
Canvas	6
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Forms of Tenders can be obtained on payment of 6d. each from the Stores Superintendent, General Stores Department, G.S. Rlys., Inchicore, Dublin. Applications for forms by post must be accompanied by postal order. Stamps cannot be accepted. All enquiries for information should be directed to the Stores Superintendent.

Patterns may be inspected at the General Stores Department, Inchicore, on and after the 13th instant, between the hours of 10 a.m. and 4 p.m. (except on Saturdays).

Tenders must be enclosed in the envelope supplied for the purpose with each schedule, and must be posted so as to be with the undersigned before 5 p.m. on Wednesday, 25th May, 1927.

The Directors will not consider any Tender unless it is furnished on the Company's form and do not bind themselves to accept the lowest or any Tender.

The decision of the Directors will be communicated not later than Friday, the 8th July, 1927, to those firms only whose Tenders are accepted.

By Order,
C. E. RILEY,
Secretary.

Kingsbridge Terminus, Dublin,
May, 1927. 5410

Halstead Rural District

COUNCIL.
EARLS COLNE DRAINAGE.
CONTRACT NO. 2.
TO CONTRACTORS.

The Halstead Rural District Council are prepared to receive TENDERS for the CONSTRUCTION of about 1 MILE of STONEWARE and CAST IRON SEWERS of 9in. and 7in. diameter, together with MANHOLES and other APPURTENANCES; and for the CONSTRUCTION of a PUMPING STATION and about ONE-THIRD of a MILE of 7in. diameter CAST IRON RISING MAIN, TWO SETTLEMENT TANKS, EFFLUENT CARRIERS, EFFLUENT PIPE, FENCING, and other WORKS at Earls Colne, Essex, within 1 mile of White Colne Station, all in accordance with plans and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

Copies of the specification, bill of quantities, and form of Tender may be obtained and the drawings may be seen at the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Sealed Tenders, endorsed "Earls Colne Drainage, Contract No. 2," addressed to the undersigned at his offices, must be received before 10 a.m. on Wednesday, the 25th day of May, 1927.

The Council do not bind themselves to accept the lowest or any Tender.

By Order,
S. R. LONG,
Clerk to the Council.

Union Offices, Halstead, Essex,
28th April, 1927. 5390

The South Indian Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. ROLLED STEEL DISC WHEELS and AXLES.
2. STEEL TYRES for CARRIAGES and WAGONS.
3. LAMINATED SPRINGS, &c.
4. STEEL WORK for BRIDGES.
5. COPPER TUBE PLATES (FLANGED).
6. STEEL DRAW-BARS for WAGONS.
7. ROLLED STEEL ANGLES and STEEL BILLETS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Rolled Steel Disc Wheels and Axles," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 20th May, 1927.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of Specification No. 1, of 10s. for each copy of Specifications Nos. 2, 3, 4 and 5, and of 5s. for each copy of Specifications Nos. 6 and 7.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, Westminster, S.W. 1,
3rd May, 1927. 5416

PUBLIC NOTICES

City of Nottingham.

BOOSTER PUMP HOUSE AND NO. 3 BORE-HOLE PUMP HOUSES, BURTON JOYCE.
CONTRACT NO. 11.

The Water Committee is prepared to receive TENDERS for the ERECTION of BUILDINGS, WATER RECEIVING CHAMBER, &c., at the Burton Joyce Works.

Drawings may be seen and copies of the general conditions of contract, specification, bill of quantities, and form of Tender, &c., may be obtained on application to Mr. T. Wallis Gordon, City Engineer and Surveyor, Guildhall, Nottingham, on payment of Two Pounds, which will be returned on receipt of a bona fide Tender.

Sealed Tenders are to be delivered, in the official envelope provided, to the undersigned not later than 6 p.m. on Monday, the 23rd May, 1927.

The lowest or any Tender will not necessarily be accepted, and Tenders will only be considered from firms having the necessary plant and experience and who conform with the conditions of the contract as regards paying the local standard rate of wages, &c., and with the working rules of the Nottingham district.

By Order,
W. J. BOARD,
Town Clerk.

Guildhall, Nottingham,
27th April, 1927. 5386

The Madras and Southern Mahratta Railway Company, Ltd.,

25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for :—

900 PAIRS WHEELS and AXLES for CARRIAGES and WAGONS M.G. (with DISC CENTRES and SANDBERG SORBITIC TYRES).

Tenders are due in on Tuesday, 24th May, 1927, by 2 p.m. Tender form obtainable at above address; fee One Guinea, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 5413

TO SAFE MANUFACTURERS.

THOMAS WALLIS & CO., Ltd.,

invite TENDERS for the regular supply of

STANDARD PATTERN SAFES

in quantities.

Write, giving full particulars, prices, etc., to

Office Furniture Department,
THOMAS WALLIS & CO., LTD.,
Holborn Circus, London, E.C. 1.
Telephone: Central 9731. 5393

Borough of Guildford.

WATERWORKS EXTENSIONS.
CLERK OF WORKS.

The Corporation invite APPLICATIONS for the APPOINTMENT of CLERK of WORKS in connection with a Contract for Laying 2913 Yards of 18in. and 594 Yards of 6in. Cast Iron Water Mains in the borough area.

Applications, stating the age of the candidate and accompanied by copies of three recent testimonials, should state details of the candidate's experience in supervising work of this character and particularly in the use of lead wool for pipe joints, and should be sent by post to the Consulting Engineer, Mr. Percy Griffith, M. Inst. C.E., F.G.S., 39, Victoria-street, Westminster, S.W. 1, not later than the 13th of May, 1927.

The appointment will be for the period required for the completion of the contract, or for such other period as the Corporation may determine. Salary £6 6s. per week.

C. H. WOOD,
Town Clerk.

Town Clerk's Office, Guildford,
May, 1927. 5394

Egyptian State Railways.

REQUIRED, ONE BOILER INSPECTOR, salary £480 per annum; ONE DISTRICT LOCO. SUPERINTENDENT, salary £540 per annum.

QUALIFICATIONS FOR BOILER INSPECTOR.

Must be between 30 and 40 years of age.

Must have served a regular apprenticeship either with a Railway Company or a firm of Locomotive Builders.

Must be fully qualified to examine and report on the condition of boilers.

Must have had wide experience in Boiler Repair Work.

Must have had experience in the control of men.

In addition to experience in Boiler Shop Work, experience in the Running Department of a Railway would be desirable.

QUALIFICATIONS FOR DISTRICT LOCO. SUPERINTENDENT.

Must have had a good general and technical education and hold an Engineering Degree or be a Member or Associate Member of the Institution of Mechanical Engineers or of the Institution of Civil Engineers.

Must have served a regular apprenticeship in the workshops of an European Railway and have had experience in the Running Department on the foot plate and in Shed Management.

Must be tactful and of firm character, resourceful and capable of controlling men.

Age should be about 30 to 35 years.

Appointment will be in each case for two years.

Applications should be made to
THE CHIEF INSPECTING ENGINEER,
Egyptian Government,
41, Tothill-street, London, S.W. 1,
from whom copy of application form and copy of contract form can be obtained. All communications should be marked at top left-hand corner "Boiler Inspector" or "District Loco. Superintendent." 5341

Required by the Port of London Authority,

the SERVICES of a First-class DRAUGHTSMAN, capable of designing Steel Bridges, Lock Gates, Caissons, and other items in the equipment of a large port.

Applicants are required to have a sound theoretical knowledge and practical experience of steel work construction.

Scale of pay £300, rising by annual increments of £15 to £425 per annum.

Commencing salary according to qualifications.

Applications, stating age, training and experience, should be addressed to the STAFF MANAGER, Port of London Authority, Trinity-square, E.C. 3.

J. D. RITCHIE,
Secretary.

2nd May, 1927. 5420

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED for a British Engineering Firm with first-class home agencies in Bombay, an ASSISTANT with Mechanical Engineering training. Age between 24 and 28, unmarried. Commencing salary with annual increases the equivalent of £450 to £500, according to qualifications.—Reply in writing, with copies of testimonials and, if possible, a photograph, to Box Z.P. 247, c/o Deacon's Advertising Agency, Fenchurch-avenue, London, E.C. 3. 5430 A

WANTED, SIX First-class COMBUSTION ENGINEERS; experience Pulverised Coal essential.—Apply by letter, giving full qualifications, experience, and salary required, BOLTON and PARTNERS, Limited, 3, Iddesleigh House, Caxton-street, S.W. 1 5360 A

HYDRAULIC ENGINEER, with Proper Drawing-office and practical experience relating to Water Power and Irrigation Work, REQUIRED as Head of Drawing-office, London.—Address, 5428, The Engineer Office. 5428 A

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

The Tees Improvement Scheme.

IN a Journal note published in our issue of March 11th we outlined the new proposals of the Conservancy Commissioners for improving the river Tees. At a meeting of payers of Tees dues, wharf-owners, shipowners and representatives of industrial undertakings, which was held at Middlesbrough on Monday, May 2nd, details of the new scheme for the proposed deepening, widening and the general improvement of the river were given by Sir Hugh Bell, chairman of the Tees Conservancy Commission. Sir Hugh traced the development of the Tees from the tortuous narrow stream of 1852 when the Tees Commission was formed, to the existing waterway which can now accommodate vessels of over 14,000 tons. He referred to the abandoned proposal of the North-Eastern Railway Company to construct docks at Wilton, and said that, although the Commissioners were still of opinion that the river did not offer facilities which would enable it to compete with Antwerp and Rotterdam, yet money was to be spent to reduce the difference between such ports and the Tees. The improvement scheme, which was now proposed by the Commissioners, involved, according to the engineer's estimates, an expenditure of £571,000, and the estimated cost of new plant which would be necessary to carry out the work was about £234,000. Sir Hugh went on to say that he would not attempt to disguise the fact that the revenue from the river would have to be increased by quite 10 per cent., but it was hoped that the whole of the burden of cost would not have to be met by increased charges, as the revenue from the river was increasing. It was further pointed out that there was nothing in the present scheme to prejudice the construction of new docks at some future date. The scheme, as outlined by Sir Hugh Bell, was welcomed by those present at the meeting.

The Institute of Fuel.

As the President of both the Institution of Fuel Technology and the Institution of Fuel Economy Engineers, Sir Alfred Mond, it will be recalled, suggested in November last that the two existing Institutions should be merged into one new body. At a meeting, which was held at 37, Lowndes-square, S.W. 1, on Friday afternoon of last week, April 29th, under the chairmanship of Sir Alfred, the final steps for the fusion of the two Institutions were taken, and the newly constituted Institute was brought into being. It is announced that the name of the merged Institutions will be "The Institute of Fuel," and that the Councils of both the Institutions have been united to form a single Council. A new Council will be elected by ballot in the coming autumn. The honorary secretaries of the two Institutions are the joint secretaries of the new body. Sir Alfred Mond, who proposed the formal resolutions to give effect to the fusion, expressed his gratification that the union had been successfully accomplished, and thanked all who had co-operated to bring it about. He referred to the interest which the Government was showing in the important problems connected with fuel economy and technology, and went on to say that he was Chairman of the National Fuel and Power Committee which had been appointed by the Government. That Committee, Sir Alfred Mond said, was progressing favourably with its work, and it was of the utmost importance, he thought, that there should be a unified institute to advise both it and the community on technical matters. The resolutions were seconded by Sir Hugo Hirst, who also referred to the necessity of a unified body which could deal authoritatively with the problem of fuel technology. Sir William Larke proposed and Sir Philip Dawson seconded that Mr. H. L. Pirie and Mr. Edgar C. Evans, the secretaries of the respective institutions, be appointed the joint honorary secretaries of the new Institute of Fuel.

The Swedish-American Motor Liner Gripsholm.

IN THE ENGINEER for November 27th, 1925, and the two following issues will be found a full description of the 18,000-ton Swedish-American twin-screw liner Gripsholm, the first Transatlantic motor liner, which, it will be recalled, was built by Sir W. G. Armstrong, Whitworth and Co., Ltd., at Newcastle-on-Tyne, and equipped with Burmeister and Wain double-acting four-cycle engines of 13,500 total propulsive S.H.P., along with three 500 B.H.P. oil engines driving electric generators, and three 700 B.H.P. engines for the main air compressors. Burmeister and Wain, Ltd., have recently published the actual log data for the Gripsholm during the whole of her first year of service, which included ten round voyages from Gothenburg to New York, and a short cruise in Scandinavian waters in July, 1926. The results, which are reprinted in brochure form, with illustrations and drawings of the ship and her machinery, will be of considerable value to all who are interested in the progress of the large motor-propelled liner. We note that the average amount of fuel oil used on the maiden voyage for all purposes per twenty-four hours was only 64·75 tons, which was made up of 47·2 tons for the main engines, 10·4 tons for generators and compressors, 6·4 tons for the heating boiler, and 0·75 tons for the galley. The vessel made an average speed, according to the log, of 16·35 knots, the maximum speed for twenty-four hours being 17·3 knots in fine weather. In some of the later voyages the fuel consumptions were down to 55·92 tons of oil fuel per twenty-four hours for all purposes, and a figure of 53·87 tons of fuel used was obtained when cruising at 16·3 knots. From the particulars given, we note that the engines behaved well in all weathers, both under full power and when manœuvring, and there was no necessity to prolong any stay in port for inspection or overhaul, while the machinery, after the tenth voyage, was found in complete working order.

Mr. Maurice S. Gibb.

THE election of Mr. Maurice S. Gibb as President of the North-East Coast Institution of Engineers and Shipbuilders, in succession to Sir Eustace Tennyson d'Eyncourt, will be well received in marine engineering circles in the North of England. The new President is managing director of the Central Marine Engine Works of William Gray and Co., Ltd., of West Hartlepool. He obtained his practical training at those works and afterwards went to sea as a marine engineer in ships of the Aberdeen Line and the White Star Line. Before returning to the Central Marine Engine Works, Mr. Gibb was for some years outside machinery superintendent for the North-Eastern Railway Company. During the war period he was Director of Munitions Supply at the Ministry of Munitions, and was later the representative of the Ministry in charge of the national projectile factory at Birtley. Mr. Gibb has been an active member of the Institution of which he has now been elected President, and is one of its representatives on the Technical Committee of Lloyd's Register of Shipping. In recent years Mr. Gibb has interested himself in improving the efficiency of the quadruple-expansion marine steam engine. Engines designed for a working pressure of 265 lb. were installed by the Central Marine Engine Works in the Ellerman liner City of Bath, special features of the machinery equipment being air pre-heaters and high-pressure feed heaters.

Recently Re-conditioned Steamships.

THE reconditioned White Star liner Albertic, which sailed from Liverpool with a large complement of passengers for Montreal, arrived on April 30th. She is believed to be the largest steamship to call at Montreal with passengers. The Albertic was formerly the Ohio of the Royal Mail Company's Southampton-New York service, and is a ship of 18,940 tons gross. Another liner which, having undergone extensive alterations at the yard of her builders, Harland and Wolff, Ltd., of Belfast, has now been returned to her owner, the Pacific Steam Navigation Company, is the 15,500-ton Orbita. The boilers of this vessel have been converted for oil burning, and the ship has been adapted for the South American service by the alteration of the passenger accommodation from cabin and third class to first, second and third class. Some ten days ago the Canadian Skirmisher, belonging to the Canadian Government Mercantile Marine, sailed from the Mersey to St. John, N.B., to take up regular service between Canada and the British West Indies. About ten weeks ago this ship arrived at the Birkenhead yard of Cammell Laird and Co., Ltd., as a cargo vessel and, in a short space of time, she was converted for passenger service by the fitting up of cabin accommodation. A sister ship, the Canadian Pathfinder, is also undergoing conversion at Birkenhead, and it is expected that she, too, will be completed in record time. Good progress is being made with the reconditioning of the Canadian Pacific liner Empress of Australia by the Fairfield Shipbuilding and Engineering Company, Ltd., and she is expected to make her first sailing to the St. Lawrence at the end of June. On Wednesday last the White Star Liner Calgaric, formerly the Orca, of the Royal Mail Steam Packet Company, which has been reconditioned and had third-class accommodation added, sailed from Liverpool for Canada. She is a 16,000-ton Harland and Wolff-built liner, with a length of 575ft., and is propelled by triple-screw machinery, with a central low-pressure turbine and four-cylinder triple-expansion engines on the wing shafts.

Cruisers to be Scrapped.

IT is officially announced that the cruiser Conquest is to be paid off for disposal early next year. This ship is a unit of the numerous "C" class, which at present comprises more than half of our entire cruiser establishment. Although the vessels in question were built with a special view to service in the North Sea, primarily as scouts and flotilla flagships, they have been largely employed since the war on foreign service, despite their modest displacement, restricted endurance, and cramped accommodation. As their place is taken by the new "A" and "B" class ships of ocean-going design, they will be transferred to the sale list, the first to go being those which no longer justify the expenditure of heavy sums of money on extensive repairs. The Conquest, a sister to the Centaur, was built by Armstrongs, and completed in December, 1916. She saw a great deal of arduous service, but shared with her sister vessels the extraordinary immunity of this class, no unit of which was destroyed by the enemy, though many sustained damage from mine and torpedo. The Conquest is a ship of 3750 tons, equipped with Parsons turbines of 40,000 shaft horse-power. The contract speed of 28·5 knots was attained with difficulty, owing to the addition of many fittings not provided for in the original design. The present armament consists of five 6in. guns and two 3in. A.A. pieces, with two submerged torpedo tubes. The ships of this class have excellent underwater protection, and showed themselves capable of resisting severe punishment. They have, however, been rendered obsolete by the new 10,000-ton cruisers, armed with 8in. guns, which the Washington Treaty has virtually imposed as the standard type of the future for all navies. It is only a question of years before the last of the twenty-five "C" class cruisers now on the Navy List is handed over to the shipbreaker.

Mechanization in the Army.

ON May 1st, as officially announced by the War Office, Colonel R. J. Collins, late Director of Military Training in India, took over the command under the orders of Major-General Sir John Burnett-Stuart, of a new experimental force of completely mechanized units which is being assembled at Tidworth. The object aimed at in creating this new force is to discover from practical experience the effect of mechanization on the organisation and the tactical employment of highly mobile units. It is stated that the force will include a tank battalion; an armoured car company; a field brigade, Royal Artillery; a pack battalion, Royal Artillery; a field company, Royal Engineers; a signal unit; and an infantry battalion re-equipped as a machine gun unit with thirty-six machine guns. The hope is expressed that the results of the tests to which the various units will be subjected during the training season will be of very material value in guiding the further development of mechanization in the Army as a whole.

Cambridge University Appointments Board.

IN dealing with the subject of engineering education at the University of Cambridge in our issue of October 24th, 1924, on which occasion we published a full description of the laboratories of the engineering department of the University, reference was made to the success which had attended the efforts of the Appointments Board, in finding posts for graduates from the Cambridge Engineering School. We have just received from the Board a report of its twenty-five years' work, which ended February 27th, 1927. In it the origin and constitution of the Board are dealt with, and its work is described and reviewed. Particular interest attaches to the period embracing the years 1921–1926. In those years over 757 educational appointments have been filled. Some 177 firms and industrial organisations have appointed Cambridge graduates on the administrative sides of their businesses, whilst 47 firms have taken scientific assistants. Turning to engineering, appointments have been made by no less than 128 different bodies representing all branches of engineering activity, and 409 graduates were placed. Works experience was further obtained by 111 students during the long vacation. Other appointments include those made in agriculture and forestry, whilst administrative and scientific appointments in the Civil Service, in the Crown Colonies, as well as civil, scientific and railway appointments at home are recorded. In the report referred to statistics dealing with appointments and registrations are given. From the tables in the report it would appear that of the total number of students taking the degree of Bachelor of Arts in any given academic year, about one-half register their names with the Board, and about one-third of the whole number, or three-fifths of those who make application, obtain appointments through the Board.

Floods on the Mississippi River.

ON Friday of last week, April 29th, engineers blasted away by dynamite a portion of the levee or embankment of the Mississippi at Poydras, fifteen miles below the City of New Orleans, with the object of reducing the flood level of the river. In the year 1922, in a similar situation, a failure of the levee at the same point in the river lowered the water level at the city some 2ft. in thirty-six hours. The operation, which was carried out on Friday last, and which has since been supplemented by further widenings of the breach then made, has, however, only served to lower the level of water at New Orleans some 5in. Additional complications have arisen owing to the river Mississippi and its tributaries breaking the levees at points north of Vicksburg and New Orleans, and there is fear that the return of these flood waters from upper Louisiana may counteract, to some extent, the relief afforded by the spillway made at Poydras. President Coolidge has instructed the U.S. Army Corps of Engineers and the River Mississippi Commission to draw up a comprehensive plan for submission to Congress in order that future floods may be prevented.

The Modern Steam Engine and Internal Combustion Motors.

By MAURICE DEMOULIN.

No. IV.*

THE use of high pressures in boilers could not alone increase the efficiency. It was also necessary to know how to use steam economically in the engine itself. The problem to be solved can be thus stated: Expand the steam in the cylinders or in any receiving apparatus, such as turbines, up to the limit corresponding to the vacuum in the condenser, which ought to be as high as possible. The problem would have been easily solved were the engine cycle ideal and adiabatic, which it is far from being. In other words, when the difference $T-t$ which corresponded to a theoretical efficiency of 44 per cent. was obtained, there occurred in the whole cycle losses of heat which lowered in a great measure the final efficiency. These losses have been the object of long and profitable researches by Clausius, Rankin, Hirn, Cotterill, Thurston and many others, and are, as is well known, completely analysable to-day.

The expansion of saturated steam in one cylinder is only suitable for relatively low pressures—say, for example, 90 lb.—by reason of the initial condensation which takes place in the cylinder and materially lowers the efficiency. This defect increases rapidly with the ratio of expansion. Decisive and well conducted experiments made years ago in France showed that, for a Corliss engine, condensation thus caused for saturated steam increased from 14 per cent. for a working pressure of 64 lb. with an admission of 30 per cent. of the stroke, to 53 per cent. for a working pressure of 128 lb. and an admission of 4 per cent. Saturated steam is far from possessing the properties of a perfect gas. It is therefore bad policy to expand such steam in one cylinder, whatever be the system of valve gear, and in spite of the use of a steam jacket, to more than three to four times its initial volume. If expansion be carried further, internal condensation and re-evaporation occur to a degree which is notably detrimental to thermal efficiency; high piston speeds being only a partial remedy. This state of things has involved the adoption of multiple expansion engines, first compound and, as working pressure increased and necessitated greater expansions, of triple and even quadruple-expansion engines.

To obtain in a single-cylinder engine an expansion of ten times, the cut-off should be, of course, one-tenth of the stroke and that is accompanied by high internal condensation. But if we consider a triple-expansion engine in which the ratio of volumes of low-pressure to high-pressure cylinder is, for example, $r = 7$, then the total ratio of expansion will be theoretically at least $\frac{r}{\alpha}$, where α is the ratio of admission in the high-pressure cylinder. If $\alpha = 0{\cdot}45$, the total ratio of expansion will be $15{\cdot}5$. In these conditions the initial condensation will be much reduced, but it will exist, and we shall see later how to reduce it. Another well-marked advantage of the multiple expansion engine consists in the fact that the differences of pressures between the two faces of the same piston or piston valves being small, the leakage is much less than in a single-cylinder engine. Moreover, great expansions may be obtained with ordinary valve gears, an advantage with saturated steam, but not altogether, as we shall see, when steam is much superheated.

The ratio of expansion is limited, in the reciprocating engine even when the vacuum is high, since the volume of the low-pressure cylinder cannot for practical reasons be as great as would be necessary to use all the expansion of steam. We must add also the influence of cooling by radiation of a very large low-pressure cylinder and of the friction of the piston and slide valves. It is therefore not possible, with this type of engine, having ordinary slide valves and working with long admissions, to profit to the fullest extent by the very complete vacuum obtained in modern condensing plants. Hence, the great advantage of turbines in this respect, as the expansion can be pushed as far as possible and further than was thought necessary or possible some years ago.

Modern steam turbines are very remarkable and perfect machines, and it would be unfair not to recognise that their inventors and makers have displayed, in their design, at least as much inventive power and perseverance as the promoters of internal combustion engines. It is even a more original device, as everything had to be created, while for the latter it was necessary only to adapt the piston engine to its requirements, and as the gas engine had already led the way.

Another advantage of turbines, if compared with Diesel engines, consists in the smoothness of their starting and manœuvring, the regularity of their turning moments, as well as in the absence of bending and shearing stresses in the shafts. These shafts are much less exposed to fatigue or breakage than those of other types of heat engines, particularly the internal combustion engine.

Steam turbines, as is well known, in order to obtain the best efficiency, are designed for high speed, which makes it necessary in marine designs to have a speed reduction gear from the turbine shaft to the low-speed propeller shafts, so as to secure the best efficiency both of the prime movers and of the propellers. These reducing gears are mechanical, hydraulic, or electric. The first is by far the most generally used, but the hydraulic gear, more particularly patronised by German firms, has a great flexibility and allows the reversing of propellers without the turbines being reversed. On the other hand, its mechanical efficiency is low. Electrical transmission, though capable of adaptation to the propulsion of all kinds of ships, seems more especially designed for high-powered passenger vessels or warships, and possibly for large cargo boats. It has also been fitted to propelling machinery of the Diesel type, as it furnishes a good solution for the reversing of propellers, the weak point of these motors. It can no longer be considered as in the experimental stage, being used on a large scale for more than ten years in the United States Navy in particular. It is a very interesting device, as it allows several arrangements of machinery and propellers, the use of high-speed turbines, and eliminates the reversing turbine losses. Though experience has shown that the system can be successfully operated there are many engineers, I believe, who would hesitate, rightly or wrongly, to rely exclusively, for a sea-going vessel, on electric equipment. The reliability of the pinion gear is absolute.

Owing to the high speed at which turbines run, they can be coupled directly to alternators, a circumstance which has contributed to their general extension in electric stations; but recently some makers have adopted impulse turbines of small diameter and volume, which run at a very high speed and with which, for driving alternators, reducing gears must be used.

Pinion reducing gears having, on fast and powerful steamers, to convey large powers at very high speed, have to be designed and finished with the utmost care in order that they may work with absolute trustworthiness and noiselessly.

Many improvements have been effected in the disposition of turbines on board ship and the mode of driving the propeller shafts; one of the most important is that realised in the simple and first arrangement with three shafts and one H.P. and two L.P. direct turbines; the aid of reducing gears, enables one H.P. and one L.P. and reverse turbine to be coupled to one shaft. With such a system, in ships fitted with several propellers, the shafts are independent, as with reciprocating engines, and each of them can be used for reversing and, in case of damage to one propeller or to one set of turbines, the ship can still continue its voyage. Reducing gears have also made it possible to drive the single shaft of any type or size of cargo boat with H.P. and L.P. high-speed turbines operating through the same main pinion. I have thought it useful to recall these well-known facts, so as to give a general view of the question.

Whatever be the advantages of marine turbines, they do not deprive reciprocating engines of qualifications of their own. In the first place, the efficiency of turbines is at the maximum only when they develop their normal and generally their maximum power, and this efficiency decreases rapidly at low speeds. This is of small importance for passenger or cargo steamers sailing normally at a constant speed, but the case is quite different for warships, such as cruisers. In such ships makers have sometimes coupled turbines to a reciprocating engine, each driving a different shaft, the central one being commanded by the reciprocating engine, which is used alone for reduced speeds or for manœuvring, as it is more reliable and quicker and can stop the ship more rapidly.* This engine, when full power is to be obtained, exhausts into the wing turbines. A similar disposition was proposed and has been applied to high-powered vessels to combine the high efficiency of turbines for low-pressure working, with that of alternating engines of which the efficiency is best at high pressure. The adoption of one or two impulse wheels at the admission end of the high-pressure turbine has reduced the interest in such arrangements, and is not always effective, for it is recognised that the gain obtained in steam efficiency may be more than counter-balanced by the losses arising from the propinquity of neighbouring propellers.

In order to remove this defect a German firm has recently devised a system in which a comparatively slow reciprocating engine is coupled to the same shaft with a turbine. This disposition is evidently limited to moderate-powered ships. The reciprocating engine drives the screw shaft directly, whilst the turbine is connected with it by means of a reducing gear with the interposition of a hydraulic coupling, which permits it to be disconnected or connected whilst running, but smoothly and without any dangerous impact. This system has yet to prove its practical value, the connection between the main shaft and the turbine being its weak point. Upon the whole, the coupling of a turbine with a reciprocating engine enables a greater expansion to be obtained and the full benefit of the maximum vacuum can be employed. If the turbine can be easily disconnected, all the advantages of both systems, alternately or when working together, are available.

Thus far we have only considered those devices which render it possible to obtain, in the best conditions, as great an expansion as possible of saturated steam. They represent, upon the whole, arrangements of a purely mechanical order. But, interesting as they are, they are not sufficient, and an important step remained to be made, and one which the past twenty years have seen taking more importance every day; that is to say, to modify the working conditions of the working fluid, and to improve its quality, apart from all mechanical devices. It has consisted in converting steam into a fluid as similar as possible to a permanent gas. This departure, considered formerly as inadvisable on account of risks of injury to engines, is simple, and so efficient that it may be regarded as constituting one of the greatest steps that the steam engine has ever made. Such a gas is a good non-conductor of heat and can part with a notable quantity of the calories it contains without any condensation taking place under the cooling action of the metal of the cylinders. It is therefore possible to conceive that engines designed to use such a fluid may offer some divergencies from those designed for saturated steam and that high superheating will open up new fields of research and application.

If steam is sufficiently superheated beyond its saturation point t in a special and separate apparatus heated by the products of combustion in the furnace of the main boiler, say, to a temperature t^1, it will act as a gas as long as $t^1 > t$. If even the difference $t^1 - t$ remains positive up to the end of the expansion, no condensation whatever will be produced during the whole cycle. When the engines are designed for a long expansion, this condition is realised with much difficulty, as it would need an excessively high initial temperature, though the internal combustion engine has shown, as far as the pistons and their rods in double-acting motors are concerned, that the lubrication could be effected at higher temperatures. But, of course, these motors do not admit of the use of slide valves or gears exposed to the action of hot gases and subjected to friction. It is one of the main reasons why the temperature of superheated steam for reciprocating engines is limited to about 660 deg. Fah., whilst 750 deg. Fah. is now common when turbines are used. For an initial pressure of 500 lb., frequently adopted for central stations the difference, of temperature between saturation and superheating is not greater than 282 deg. Fah. Nevertheless, this superheating is sufficient to effect an economy of steam which may rise to as much as 20 per cent.

Superheaters are now an addition, not only usual, but almost obligatory for all plants of importance. They are also generally fitted to locomotives and they constitute, for these engine, about the only real progress towards steam economy which has been made since the steam locomotive began. With their help such engines can attain a good thermal efficiency with moderate W.P. such as 170 lb. instead of the 230 lb. adopted for some compounds with a much more moderate success.

Superheated steam was first used with some hesitation, as difficulties of internal lubrication were feared. Experience has shown that, thanks to the use of suitable oils and a good disposition of the oil pipes leading to valve boxes and cylinders, this fear was not well grounded. Thousands of locomotives are now running in all countries with steam superheated to 650 deg. Fah. at least, without any other precautions being taken than adequate lubrication of cylinders and valves; even more, some railways—America was the first in this direction—are satisfied with lubricating only the steam before its admission to the cylinders, but with special oils, of course. Railway engineers have become so thoroughly accustomed to superheating that they do not think nowadays, at least for main line service, of saturated steam engines. Superheating allows of an increase of power that may reach 20 per cent.

Superheated steam has, it is well known, if compared with saturated steam, a drawback, namely, its great fluidity, which results in a greater tendency to leakage past the valves and pistons. It is, I believe, the principal, if not the only reason, why French railways have kept to compound locomotives, even with superheating, the superheated steam leaking through the high-pressure pistons and piston valves being expanded in the low-pressure cylinders, instead of exhausting to the atmosphere. But it may be questioned if the extra complication is worth the economy thus obtained.

This fluidity of superheated steam is a strong argument in favour of the use of poppet valves instead

* No. III. appeared April 29th.

* It may be interesting to give a brief account of some experiments conducted at the time of the first application of turbines to 22 knots passenger steamers of a certain line, in order to compare their manœuvring capacities, the distance run over after reversing and the time taken for this operation at the reduced speed of 12 knots. The results have never been published. The two steamers were of equal length and displacement. The first was fitted with triple-expansion twin-screw engines, the second with non-geared turbines—one high-pressure, two low-pressure—driving three shafts, and more powerful than the reciprocating engines. Still water. The triple-expansion engines were reversed without even shutting the throttle valves, the engines turning at about 120 revolutions. The shafts began to turn astern 5 seconds after the signal for reversing was given, and the boat, thanks also to its large propellers, came to a dead stop in a distance slightly less than its own length, about 272ft. The turbines, of course, did not stop so quickly, and their shafts began reversing, in one case after 20 seconds, in another 26 seconds, and the ship was not stopped before it had run about 1·6 times its length. It is needless to say that such experiments are undesirable, as they throw dangerous stresses on the shafts, particularly the screw shafts, at least in reciprocating engines. Moreover, turbine steamers have since shown that their manœuvring capacities are amply sufficient for practical purposes.

of slide valves. Why should not the steam engine be fitted with a gear of that kind, provided that it would give the same facilities as the slide valves do, for reversing and manœuvring? We shall see further that this problem has already been solved in the most practical manner.

The turbine seems, at first sight, better adapted than the reciprocating engine to the use of superheated steam, as it presents no internal parts subjected to friction. Yet it is not without drawbacks. Of course, most turbines work in good conditions with steam at a very high temperature, but in some systems difficulties have arisen in this respect, especially if the casing and rotor blades have insufficient play to allow for expansion. It has been proved by experience, too, that some materials or alloys are not suitable for the manufacture of blades, exposed to rapid corrosion and wear under the action of steam, especially at high temperature. Concerning the question of expansion, a relatively sudden difference of pressure of 100 lb. in the boiler with saturated steam—rather an exceptional occurrence—may have for result the small range of temperature of 20 deg. Fah., whilst, for superheated steam, irregular firing or an unsuspected change in the grade of coal might almost instantaneously occasion a drop of temperature of 200 deg. Fah., or, on the contrary, a serious increase. It is therefore necessary that the engine, whatever may be its type, shall be able to endure such changes in the temperature of steam, even if not frequent. The reciprocating engine, even horizontal, does not suffer by it between certain limits. For example, a locomotive leaves the terminus with steam absolutely non-superheated; as the draught increases and when the engine exerts all its power, after a very few miles running, superheating rises progressively and the maximum temperature, initially of some 375 deg. Fah., quickly reaches 660 deg. Fah. I am not aware that any untoward incident has ever resulted from such fact of daily occurrence.

Regarding turbines, the problem has been equally satisfactorily solved, as said above, and some great electric stations work normally with superheated steam at 750 deg. Fah.

The temperature of superheated steam declines very rapidly between boilers and engines if the pipes are long and not provided with efficient lagging.

The use of steam at high temperature, even saturated, and, above all, when superheated and subject

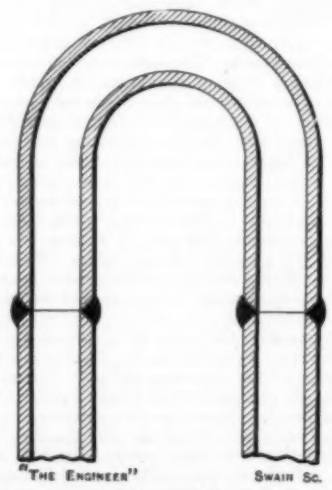

FIG. 3—WELDED SUPERHEATER TUBE

to large fluctuations, has led to the rejection of copper—and especially electrolytic copper—for the manufacture of main steam pipes and to the general use of solid drawn steel. One has, moreover, on the large ship as well as in the great electric stations employing a number of boilers, to take the necessary steps in order to allow their free expansion, either through appropriately bent portions or sliding joints or expansion glands. Bent pipes do not present any danger with steel, as they did with copper, and expansion joints do not always give satisfaction, if not looked after with great care, and they are subject to leakage. Some makers are now making use on board large ships, of rows of small diameter pipes, instead of large single mains. The chances of accident are thus lessened in case of damage to one of these pipes—damages extremely rare with solid drawn steel, which never bursts open like copper pipes. When pitting occurs it is generally local and can scarcely cause more than a leakage of little importance. Moreover, steel pipes are soon coated inside with a greasy layer incorporating some portion of salt or oxide, from the boilers, which protects them from pitting. But such pipes must be inspected outside, as their external surface may have a tendency to rust and deteriorate under the action of moisture in the upper part of the stokeholds. Their lagging must be taken off once a year at least, on board, and they ought to be examined thoroughly and well greased before they are covered anew. Nothing happens, however, as long as the presence of the external bright scale of oxide, resulting from the drawing, is maintained.

Great care must be exercised in the designing and manufacture of superheaters, for they are, at one end, exposed to the direct action of flames or hot gases and are not cooled internally as water tubes are. Superheater tubes of small diameter are most generally disposed in the shape of an U, but too long to be made of one piece. The two parallel branches of each element are connected together by different processes. The best, for water-tube boilers at least, is represented by Fig. 3, the bent steel tube being welded as shown, acetylene, or rather electric, welding being the most reliable method to use for this part of the superheater. The ends of the tubes are cut with bevels at 45 deg. The external flange made by welding must protrude sufficiently to insure the strength of the joint. When possible, each element should be carefully annealed after welding.

(To be continued.)

Institution of Mechanical Engineers.

ON Friday evening of last week Professor F. C. Lea and Mr. F. Heywood presented before the Institution of Mechanical Engineers a paper entitled "The Failure of Some Steel Wires under Repeated Torsional Stresses at Various Mean Stresses Determined from Experiments on Helical Springs." Previous investigations of the phenomenon of fatigue in metals have covered experiments in which the applied stress has ranged from a maximum tension to an equal maximum compression, or, as in the Haigh machine, experiments in which the stress has varied from a maximum tension or compression to some tension or compression of lower value. In repeated

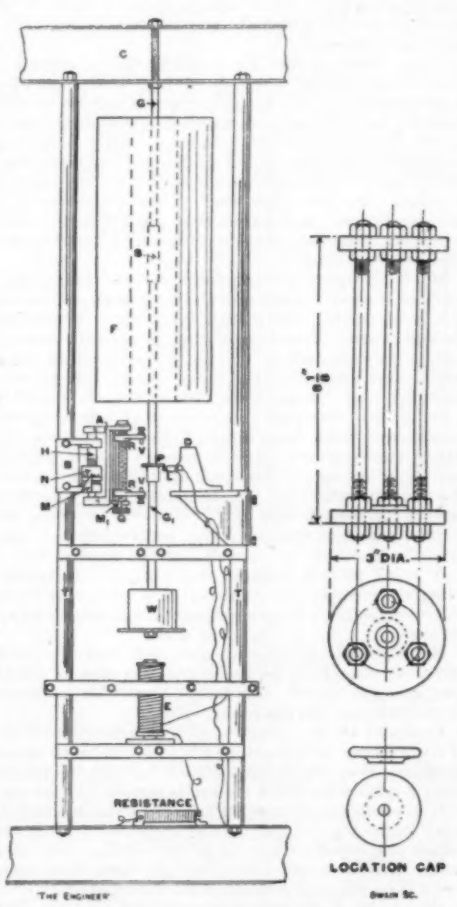

FIG. 1—APPARATUS FOR TESTING SPRINGS
FIG. 2—CAGE FOR COMPRESSION SPRINGS

shear experiments considerable work has been done with specimens to which a stress was applied, ranging from a maximum in one direction to an equal maximum in the other; that is to say, with ranges of stress of which the mean value was zero. Very few experiments have been recorded on the effect of repeated applications of a range of shear stress, of which the mean value was other than zero. It was the object of the authors' work to carry out such experiments.

The specimens used by the authors were in the form of helical springs. The apparatus devised for testing them is illustrated in Fig. 1. It consists of a frame 6ft. 6in. high composed of top and bottom channels C supported by solid drawn steel tubes T. The spring specimen S is suspended from the top channel by a rod G and has attached to it a rod G_1 carrying a weight W. A plate P, fixed to the rod G_1, is arranged, when the spring vibrates, to make contact with a rocker L on a bracket D. This rocker makes and breaks an electrical circuit, containing a resistance and an electro-magnet E. The amplitude of the oscillation maintained in the spring is controlled by varying the resistance and adjusting the position of the electro-magnet.

The amplitude of the oscillation is measured by adjusting the position of two pointed set screws V V until they just touch the plate P at the top and bottom of the stroke. The screws V are carried on a right and left-hand screw R R provided with a graduated head Q. The distance apart of the screws is read on the graduated head against a fixed mark M_1. The screw R R is carried in a bracket A, which is itself carried on a screw H provided with a graduated head N and a fixed mark M. The screw H finally is supported in a bracket B, which can be adjusted up and down the tube T of the framework. By means of this arrangement the distance apart of the screws V and the height of their mean point can be adjusted and measured.

The spring specimen can, with this equipment, be maintained in oscillation, if necessary, for several weeks without stopping. The period of oscillation is the natural period of the spring under the weight W. The number of oscillations made is determined by means of a light aluminium arm operating a Veeder counter. The current supplied to the magnet is of 200 to 220 volts pressure and can also be employed to heat an electric furnace surrounding the specimen in order that tests at elevated temperatures may be made.

The complete equipment consisted of four panels, side by side, of the form illustrated in Fig. 1. The arrangement illustrated shows that adopted for testing the specimens by extension. To test them by compression, the cage shown in Fig. 2 was used. The specimen was placed inside this cage, which was connected to the rod G and was loaded through a "location cap" guided between the three rods forming the side of the cage.

The general procedure in a test was to load the specimen in tension or compression with a weight calculated to produce a known static shear stress S_M tons per square inch on planes perpendicular to the axis of the wire of the spring. The spring was then made to oscillate through an amplitude producing a stress variation from $S_M + \frac{1}{2} S_R$ to $S_M - \frac{1}{2} S_R$, where S_R was the range of stress corresponding to the amplitude of the oscillation.

Tests were carried out on eleven batches of springs.

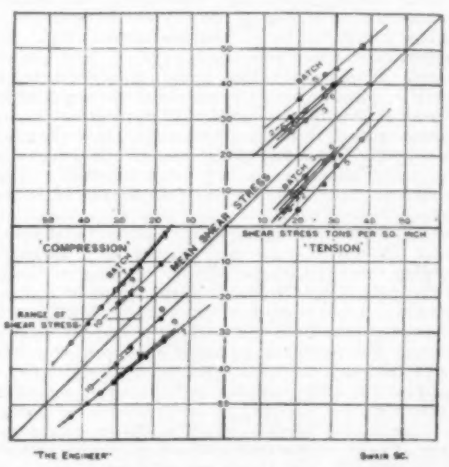

FIG. 3—RANGE OF STRESS AND MEAN STRESS

Details of the springs are given in the original paper. The material was steel of various kinds—Siemens-Martin, basic, crucible, chrome-vanadium, &c. The springs were made from wire varying in diameter from 0·071in. to 0·118in. The mean diameter of the coils ranged from 0·607in. to 1·7in., and the number of coils from 6 to 31·5. Six of the batches were tested under tension conditions and five under compression.

In Fig. 3 we reproduce from the paper a diagram summarising the results of the tests on four "tension" and four "compression" batches. As this diagram suggests, it was found that, over a considerable range of mean stress, the range of repeated stress which the specimens could withstand without fracture after in some cases as many as 44 million reversals, was given by an expression of the form $S_R = A - B \cdot S_M$, in which A and B are constants and S_M is the mean static shear stress. The constant A is the safe range of stress at zero mean stress. The two straight lines for any material intersect very approximately at the tensile strength of the material. If, therefore, the range of stress A is obtained at zero mean stress, the approximate range for any other mean stress can readily be obtained. The constants A and B vary considerably with the different steels, but it is noted that low values of A are in general associated with correspondingly low values of B.

Defects of the wire which are not brought to light by a tensile test would appear to be of very great importance and to have a considerable effect on the life of a spring. The control of the manufacture, including the drawing and heat treatment, seems to be of greater importance than chemical composition. The authors suggest that the grinding of the wire preparatory to coiling it appears to be desirable.

Before a spring of any batch was subjected to a repetition test, it was generally subjected to a static load-deflection test in order to determine the modulus of rigidity of the material. In some of the batches the modulus was found to be very consistent from spring to spring, but in others it showed a wide variation, in one case of as much as 27 per cent. The authors are of opinion that the variation was probably caused not by fundamental differences in the material, but by conditions set up by the methods of manufacture.

Tests carried out with heated specimens indicated that the safe range of repeated stress at temperatures of from 100 deg. Cent. to 150 deg. Cent. did not appear to differ materially from the range at normal temperatures.

Following the presentation of the paper by Professor Lea, his co-author, Mr. Heywood, remarked that the investigation showed clearly that the chief cause of the failure of helical springs by fatigue resided, not in the composition of the material of which they were made, but in its surface condition. The three principal factors affecting the surface condition, and causing the production of cracks were the cold drawing of the wire, the coiling of the wire into spring form and the quenching and heat treatment of the coiled spring. If the surface were removed the range of stress which the material could withstand was found to be much greater than that shown when the specimen was tested with the surface untouched. The fact that the material of which the spring was made did not have a great influence on the range of stress which the spring could withstand, was shown by experiments made on a mild steel spring. At zero mean stress, that spring was found to have the same limiting range of stress as one made of spring steel. At higher mean stresses, however, the spring steel possessed the advantage.

Mr. E. W. Bache, of Messrs. Salters, West Bromwich, opening the discussion, remarked that spring designers had for many years past felt that there was some sharply defined point below which a spring would work for many years, but beyond which it would speedily fail. The addition of a single coil to a spring had been known to make all the difference between a short and an extended life. Professor Lea's investigations clearly showed the reason for that result. Manufacturers had also found that, in some springs, a lengthening of the life was secured not by adding a coil, but by cutting one or more out. The explanation of that fact again was to be found in the paper. It was shown that springs were subjected to many stresses beyond the simple shear stress which alone was usually considered. The cutting out of a coil might reduce the maximum stress and therefore increase the life of the spring in spite of the fact that the direct shear stress had been increased. That consideration was particularly applicable to helical springs forced to vibrate in other than their own natural period and consequently open to the development of the phenomenon known as "surging." Surging consisted of the unequal opening or closing of the coils along the length of the spring at any one instant and had been shown by the oscilloscope to be a common feature in the working of certain types of spring. He would like to know whether the authors had found any difference between a spring tested in compression and a similar spring tested in tension. There was, he thought, an additional force present in compression springs which might or might not reduce the life under repeated loading. Spring makers, he remarked in conclusion, would hardly agree with the deduction that the quality of the material used was of secondary consideration.

Mr. G. A. Hankins, of the National Physical Laboratory, said that the ranges of safe stress recorded for the different batches were, in general, low as compared with the figures obtained by other experimenters. For example, at 20 tons per square inch mean stress the safe range of stress extended for the eleven batches from 15 to 30 tons. Similar work had been done by Dr. McAdam, who, in a paper before the American Society for Testing Materials, reported safe ranges of the order of 40 tons. He himself had conducted torsion fatigue tests on spring steel specimens from which the surface defects had been removed. The machine designed for the work enabled varying mean stresses to be applied to the specimens which were in the form, not of springs, but of ordinary torsion test bars. Mild steel, spring steel, normalised, and spring steel heat-treated specimens were tested on a ten-million reversal basis. The spring steels gave safe ranges of the order of 50 tons at zero mean stress, falling to 48 tons at higher mean stresses. Professor Lea's explanation of his low figures was no doubt the correct one. By the removal of the surface defects, springs could be safely loaded to about twice the safe range obtained without the removal of the surface defects. All the authors' results recorded in the paper had been obtained with specimens having surface defects, and that fact doubtlessly accounted for some of the irregularities exhibited. Some of the materials, for example the chrome vanadium steels, should not, on the strength of the authors' results, be condemned as bad materials for springs. The evidence in the paper merely implied that those steels suffered more from surface defects than others. The formulæ established by the authors to cover their results were only applicable in each instance to springs having similar orders of surface defects. His own results showed that the safe range of stress was dependent upon the material used, but was largely independent of the mean stress. For example, a mild steel of about 30 tons maximum static strength showed a safe range of 20 tons per square inch at zero mean stress and of about 19 tons at 20 tons mean stress.* Discussing the wide range covered by the moduli of rigidity which the authors had found, Mr. Hankins stated that of sixty spring steels tested at the National Physical Laboratory the modulus ranged from a minimum of $11{\cdot}3 \times 10^6$ to a maximum of $12{\cdot}2 \times 10^6$ with an average value of $11{\cdot}7 \times 10^6$. He regarded with suspicion any value departing greatly from $11{\cdot}7 \times 10^6$ and had no doubt that the authors' low figures were attributable to surface defects on the specimens.

Major C. G. Mettler, a member of the American Society of Mechanical Engineers, described the troubles experienced in the United States with helical springs, particularly in the recoil cylinders in guns, and the manner in which the difficulties had been overcome by employing hydro-pneumatic gear in place of springs.

Mr. C. E. Stromeyer expressed the opinion that the day would soon come when we should feel safer about materials subjected to variable and alternating stresses than about those subjected to static loads. Dealing with the diagram which we reproduce in Fig. 3 above, he said that, according to the authors, the two lines for any material intersected not at the ultimate shear, but at the ultimate tensile strength. He suggested that the lines, if continued, would not remain straight, but would curve towards each other and intersect at the ultimate shear strength, a point only half as far away from the origin as the ultimate tensile strength. It was, he thought, most important to clear up the question of the effect of surface defects, and as a means to that end proposed a method for grinding springs internally and externally after they had been coiled.

Wing Commander Cave-Brown-Cave remarked that, in aero-engine work, the springs used demanded most careful design. At engine speeds of 1000 revolutions per minute and upwards, surging—a phenomenon attributable to inertia—became a matter requiring very close attention. Many obscure spring failures had been traced by the oscilloscope to the development of surging. He was convinced of the importance of surface defects, and stated that great improvement in the life of springs could be effected by grinding the wire before coiling it.

Mr. C. E. Squire desired more information than was given in the paper regarding the heat treatment of the specimens tested. The materials tested by the authors showed a great variation in their chemical composition, a variation which was not encountered in practice and for which he could see no reason. He noticed that the best results were obtained from batch 5, a batch the chemical composition of which agreed most nearly with the average found in practice. In the preliminary tests which spring makers usually gave their springs, 75 per cent. of the failures were on the average caused by surface defects. He suggested in this connection that the practice of marking the springs with the maker's name, number, &c., should be reduced as far as possible, for the marks, even if they were placed towards the ends of the springs where the stresses were tapering off to zero, were likely to prove sources of trouble after the manner of surface defects.

Mr. Patchell agreed with the view that the work put into the steel, especially in the case of small springs, was more important than the chemical composition of the material.

Professor H. P. Philpot said that while the results of the authors' investigation would be useful to spring designers, they did not shed much light on the fundamental properties of the materials tested. Those properties could not be studied unless the surface defects were removed. Some of the results given in the paper suggested to him that the springs had been made from material which had not been fully identified throughout the whole of its manufacture.

Mr. J. M. Long would have liked to have seen increased differentiation made between the inside and the outside of the springs. Surface defects on the inside might, he suggested, escape notice, yet they were more important probably than similar defects on the outside, for the inner surfaces were more highly strained on account of their reduced radius of curvature. It was possible, he thought, that some materials might be better than others for the production of springs, because of their reduced tendency to develop surface defects, even although that reduced tendency were accompanied by a lower tensile or shear strength.

Mr. C. H. Wingfield gave it as a result of his experience with safety valve springs, that springs made of wire of small diameter could carry higher stresses than those made of large-diameter wire.

Sir Henry Fowler expressed his appreciation of the fact that the authors had dealt with springs as users found them, and not with springs that had been ground, although he admitted that grinding for the removal of surface defects was a most important development.

Professor Lea, replying to the discussion, stated that surging in the springs tested had been eliminated as a result of the design of the testing apparatus. The results quoted in the paper did not give the fundamental properties of the materials in their primitive form, but he did claim that they represented the fundamental properties of the materials when presented in the form of helical springs. He had carried out tests on specimens ground after heat treatment, subjecting them to alternating torsion in a machine of the type described by Mr. Hankins, and had obtained results comparable with those recorded by Mr. Hankins and Dr. Macadam. He agreed with Mr. Hankins that the modulus of rigidity of the materials tested was not really a variable quantity. The figures given in the paper were best described as the "apparent" modulus of rigidity. If that figure were low, it was generally found that the fatigue test also gave a low result.

Mr. Heywood, supplementing his co-author's reply, remarked that the springs tested had been supplied by the manufacturers who had made them and heat treated them in accordance with their usual practice. Experiments were now in progress on springs, the production of which was fully controlled by themselves throughout all the stages of their manufacture. Replying to Mr. Squire, he said that one of the batches with over twice the mean composition of batch 5 had given equally good results. Concluding, he stated that all their experiments had been conducted on springs made of small-diameter wire. He did not think their results could be applied, as they stood, to springs of large-diameter wire, the safe ranges of stress for which would probably be less than those given in the paper.

* These figures apparently imply that Mr. Hankins failed after 10 million reversals to break a loaded mild steel specimen by subjecting it to a range of shear stress which was such that the maximum value of the applied stress was 29½ tons; that is to say, only ½ ton below the ultimate static strength of the material. In a diagram which he threw upon the screen the range lines for mild steel were shown as practically parallel throughout their length. They did not intersect as did Professor Lea's lines at the ultimate static strength.—ED. THE E.

Suction Gas for Commercial Vehicles.

No. I.

THE demonstrations of charcoal suction gas for motor vehicles which were held at Blois recently are likely to terminate the series of similar gatherings that have been organised in different parts of France for some years past. They are believed to mark the end of the first stage of development, when the construction of wood-carbonising apparatus has reached a point where it appears to be commercially successful, and where the use of suction gas has been simplified to a degree that removes many of the objections formerly raised against that fuel for motor vehicles. Future demonstrations will take the form of extended tests of carbonising apparatus in order to ascertain exactly the cost of production and the quality of the product when treating different kinds of wood, while the Ministry of War has already begun to organise a particularly severe trial of motor vehicles running on suction gas, to be preceded by bench tests of long duration. No fewer than forty vehicles have been entered by twelve makers. That alone indicates the interest which is being taken in France in the utilisation of the products of woods and forests for power purposes. Primarily, the movement is due to the encouragement offered by the Ministry of War, which finds that wood is at present the only available national substitute for petrol, and, although there is reason to believe that synthetical liquid fuels will be provided in the future, it is hardly possible that any single source of supply will be sufficient to meet all requirements, and whatever may be accomplished eventually with the production of synthetical fuels, it cannot diminish the utility of charcoal suction gas if the promising results already obtained with it should be confirmed by further experience. Apart from any question of national defence and national economy, the suction gas vehicle is of particular interest in the African and other colonies where the cost of petrol is prohibitive, and where wood is found in abundance.

The first attempt to run a motor vehicle with suction gas appears to have been made by Monsieur Cazes, when he equipped a Paris omnibus with a suction gas plant in 1910. The experiment showed that public service vehicles could be run on that fuel, but, as petrol was fairly economical at that time, there was no necessity to employ any less convenient form of hydro-carbon. Immediately after the war, however, the problem became of national and economical importance. There could, of course, be no question about the possibility of running vehicles on suction gas, and, on account of the necessity of reducing the generating plant to its simplest form, it became obvious that charcoal was the only kind of fuel that could be used with any chance of success, since wood requires big scrubbers for the elimination of the tar products. It was therefore necessary to ensure that charcoal could be produced in sufficient quantities to meet all requirements. The charcoal-burning industry has been declining for many years, and, as an industry, seemed threatened with extinction. The labour involved is very heavy and the cost

is relatively high. The only hope of obtaining ample supplies of charcoal lay, therefore, in the designing of apparatus which would permit of wood being carbonised automatically. The apparatus must be portable, and must carbonise any kind of wood, such as brushwood and the refuse of sawmills. In the demonstrations carried out of late years in the Forest of Sénart, in the Landes and elsewhere, many types of apparatus were presented, some of them highly ingenious, and, in an attempt to do too much and recuperate by-products, makers defeated the end in view, which was to produce a portable apparatus that could be conveyed to any part of the forest and carbonise whatever might be available without the necessity of employing skilled hands.

The experiments carried out were evidently costly to some makers, but their confidence in the final issue was shown by the way in which they persisted in their efforts to produce apparatus which favourably impressed the experts who saw them at Blois. As on previous occasions, the demonstrations were organised with the aid of the Government Departments, the Office National des Combustibles Liquides and the many associations interested in wood carbonisation, the work of organisation devolving mainly upon the

FIG. 1—THE LORRAINE WOOD CARBONISER

secretary of the Committee, Monsieur Jagerschmidt, Principal Inspector of Woods and Forests. A Congress was, at the same time, organised by the Paris-Orleans Railway Company, which gives practical aid to any attempt at an economical development of the regions served by its railways. The carbonising apparatuses were shown in operation in the Forest of Menars. There were nine of them, and, as a means of comparing results, a professional charcoal burner produced charcoal in the dome-shaped stacks which are employed throughout the country.

In view of the early attempts to break away from the professional methods and to make charcoal continuously or to recuperate by-products in entirely enclosed receptacles, it is remarkable that out of the nine carbonising plants, eight were based upon the methods of the professional charcoal burner. The similarity was complete in the case of the Magnien apparatus, consisting of a bottom steel plate, on which are placed two conical rings, the upper ring being inserted in the lower one, and completed by a cover with a chimney. There are annular series of air vents at different heights. The procedure is therefore the same as with the charcoal burner's stack, except that the stack is not built up and the covering of litter and leaves is replaced by the steel sheet cover. The wood is lighted from above, and the air vents are plugged or opened as the combustion proceeds.

In the Delhommeau system the apparatus is built up with cylindrical sections fitting into each other, each section being made with concentric rings and lagged with non-conducting material. The cover has a central chimney and two apertures, and from the inside is suspended by chains a plate which rests on the charcoal, so as to concentrate the heat. At the bottom are air pipes to permit of the desired volume of air passing round the inside and out through the vents at the top. The volume of air is, of course, regulated and finally suppressed.

The apparatus of the Société Lorraine de Construction d'Appareils et de Distillation des Bois is of the cylindrical type, with vertical sections assembled by gudgeon pins with slots through which wedges are driven to make the whole secure. It operates on the "Bonello" systems. It is illustrated in Fig. 1, while Fig. 2 shows, in the left-hand drawing marked I., together with that in the right-hand top corner, a simple Lorraine carbonising furnace, which occupies a floor space of 2 m. by 2 m., and is 3 m. high, including the chimney. The lower drawing, marked II., on the right-hand side shows the same furnace equipped with superimposed condenser drums, which add 1 m. to the height, making the total height 4 m. The sections of the furnace have double walls packed with clay. There is one air inlet communicating with an annular chamber at the bottom perforated with holes, so that the air passes up around the wood. At the bottom of the central chimney is a cylindrical chamber with holes at the side, its object being to check the ascending gases, which are partially driven back in order to maintain the temperature inside before escaping through the holes in the chimney. Various modifications of the system of baffling the escaping gases in order to maintain the temperature inside are employed. Another special feature of the Lorraine apparatus, although not indispensable, is the condenser at the top. Around the chimney is a number of chambers in communication with it and also communicating with a pipe to a reservoir placed below to receive the tar products. Each chamber has a number of vertical tubes for air circulation. As the gases rise in the chimney, they are obliged to pass into the lower part of each chamber, and, after circulating around the air tubes, return to the chimney where they are subjected to the same refrigerating process in the chamber above. The tar products condense in the chambers and fall into the reservoir below. By the side of the central chimney are two smaller apertures which serve for the escape of the humidity in the early stage of combustion, when the wood is not quite dry, and also for watching the process of carbonisation.

The Trihan "automatic" carboniser is another apparatus in which the temperature is maintained without the necessity of regulating the air inlet. It is of the vertical cylindrical type, with double walls packed with sand. The wood rests on a convex bottom forming a chamber below, into which the air is drawn and passes upwards through a series of apertures around the circumference. When the required internal temperature is reached, the air

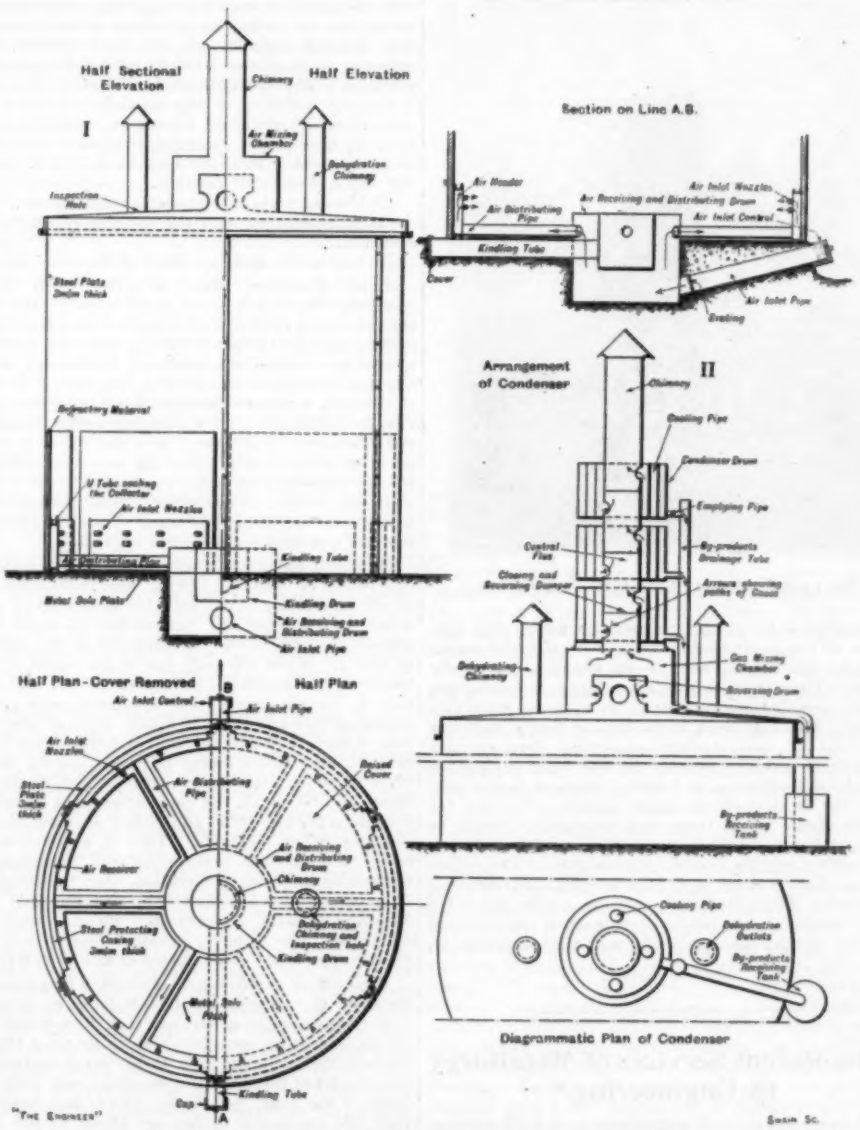

FIG. 2—ARRANGEMENT OF THE LORRAINE WOOD CARBONISER

under the convex plate expands and supplies a proportionately smaller percentage of oxygen to the wood. The cover has an inside plate of nearly the same diameter, and the gases have to pass between the plate and the cover in order to reach the central chimney. When the cover becomes hot, the expansion of the gases between the plate and the cover serves to check their velocity, and by automatically reducing the volume of air below the apparatus, and the escape of gases at the top, the temperature is maintained at just what is required for suitable combustion.

This brief description of some of the carbonising apparatus shown in operation in the Forest of Menars will convey an idea of the principles underlying their construction. There were others, such as the machine of M. Giorla—Fig. 3—in which the wood is placed in small metal cylinders hung on endless chains in such a way that one-half of them are inside a sort of square chimney above a small grate. As the wood in the bottom cylinder carbonises the gases rise and begin to carbonise the wood in the cylinder above, so that the cylinders can be removed, it is claimed, at the rate of one in five minutes with the wood completely carbonised. As a matter of fact, there is apparently no limit to the possible variations of design of carbonising apparatus, and the sole aim of makers is now to introduce wood carbonisers as simple as possible compatible with the production of charcoal of the best quality and capable of being handled by any labourer. The problem is somewhat complicated by the fact that different kinds of wood, containing more or less moisture, have to be carbonised a varying number of hours, but little experience is required to show, by the appearance of the smoke and gas, how the combustion is proceeding. With mechanical carbonisers, attention is only required during the early stage of carbonisation, so that no night labour is needed. With some of the apparatus, it is even claimed that no attention is needed at all after the wood has been stacked inside and lighted. The density of the charcoal also varies with the temperature, and a thorough knowledge of the conditions of charcoal burning is necessary to produce apparatus that will give really satisfactory results. So far as the new industry has gone, it is generally accepted that mechanical carbonisers have reached a stage of practical realisation when they can be employed by owners of fleets of motor lorries to produce all the fuel they may need at very low cost for the running of their vehicles. How the quality of the fuel produced by the charcoal burner's stack compares with that made by the mechanical carbonisers in the Forest of Menars has not yet been made public, but, judging from some of the results arrived at during the demonstration, it would appear that the mechanically-produced charcoal is more regular in quality and quite free from dirt, with, usually, an appreciably greater density. A charcoal burner's stack produces 45 kilos. to 50 kilos. of charcoal from a stère of wood, occupying roughly 1 cubic metre, while some makers of mechanical carbonisers claim that they get 60 kilos. and even more.

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There is little practical information concerning the durability of apparatus constructed with double walls of ¼in. steel plate. The temperature ranges between 300 deg. and 400 deg. Cent., and, with a cylindrical form, there appears to be little fear of permanent deformation. It is declared that an apparatus of this type has been in operation three years. The durability of the carbonising plant is obviously an important factor in its final success.

The success of charcoal also depends upon the convenience and handiness of the fuel. For that reason charcoal is offered in the form of hard compressed blocks of various shapes and sizes which have the advantage of occupying a minimum of space and of being clean to handle. Powdered charcoal is mixed with a tar binding material, and is then subjected to a sufficiently high temperature in a closed receptacle for several hours to distil out the tar and leave the hard blocks in the form of pure charcoal. The advantages of this fuel are obtained at some cost, which appreciably reduces the economical advantage, but charcoal in such form is evidently necessary if it is to be used extensively for other than the heavier types of vehicles. In the Forest of Menars powdered charcoal was even compressed into blocks with earth or clay as a binding material. The idea may be useful. It does not increase the cost of the fuel to an appreciable extent, and the only effect of the agglomerant would be to produce a higher percentage of ash.

One feature of the demonstration was to have been the working of wood-cutting and bundling machinery, especially the cutting and tying of brushwood into faggots, for the object of makers of mechanical

FIG. 3—THE GIORLA AUTOMATIC CARBONISER

carbonisers is to produce apparatus which will carbonise all kinds of wood and waste wood which exists in huge quantities, and is at present practically useless. There were only two machines, however, one being a circular saw mounted on a frame with two wheels. The disc with three sets of teeth, each set composed of two slightly staggered demi-circular projections and one saw tooth, was fixed to a shaft in front of the frame, and driven through worm gear by a belt from a small petrol motor. The disc for cutting down small trees and brushwood could be replaced by a vertical circular saw with a bench for cutting up the wood into lengths. The other machine was a chain saw with the links constituting the teeth. There will obviously be a wide scope for wood-cutting and bundling machinery if the charcoal industry should develop in the way that is promised.

(To be continued.)

Some Recent Services of Metallurgy to Engineering.*

By Professor H. C. H. CARPENTER, Ph.D., F.R.S.

IN honouring me with the invitation to deliver the James Forrest Lecture this year the Council of this Institution has expressed a desire that I should deal with the recent advances in metallurgy which have a bearing on engineering practice. It is twenty-one years since my distinguished predecessor, Sir Robert Hadfield, delivered the last lecture in which metallurgy constituted the main subject, and it would seem convenient, therefore, that I should deal with the progress made since that date.

FLOTATION CONCENTRATION.

Water concentration, which utilises differences in specific gravity between the ore and the gangue, has been practised for ages and its main principles were well understood in the time of Agricola. It is eminently satisfactory in the concentration of ore containing relatively coarse and granular mineral and a light gangue. Chemical treatment is equally satisfactory when the valuable mineral crushes to powder and the gangue is not soluble. Between these two lies the field for flotation, and this method of concentration is effective both in the presence of a heavy gangue and a fine mineral. It belongs to the present era of mining which dates back to the exploitation of the rich auriferous gravels of California and Australia about the middle of the nineteenth century. The first reference to the affinity of oil for mineral in preference to gangue, and the first suggestion to use it for the recovery of the mineral was made by William Haynes, of Holywell, Wales, in 1860. The first flotation process to be commercially applied was that developed by Elmore in London in 1898. He was, moreover, the first to apply the selective action of oil to a pulp flowing freely from a wet crushing machine. Present-day processes have developed as a result of the labours of many workers. Put briefly and somewhat colloquially, flotation is water concentration turned upside down. In flotation the mineral is floated on an air froth, while the gangue sinks to the bottom, whereas in concentration the mineral sinks to the bottom and the gangue is floated away. As an example of its present-day application I will consider briefly the modern process of "froth" flotation.

Flotation is carried into effect by the following series of operations :—

(1) Reduction of material to the necessary small size and the preparation of an aqueous pulp. It is not successful on particles larger than about 40 mesh; moreover, its particular province is to recover such fine mineral particles as, for their release, require material to be ground to 80 to 120 mesh or finer, such particles being readily floated. Flotation also requires a definite mobility of the particles in the aqueous pulp in which they are borne, experience indicating that with a sandy material a liquid-solid ratio of 3·5 to 1, and with slime a ratio of 7 to 1, represent the order of suitable dilution.

(2) Mixing with the contaminating agents.

(3) Introduction and subdivision of the air, *i.e.*, aeration.

(4) Collection and handling of the resultant froth.

Froth Flotation Machines.—Of froth flotation machines there are three main types. The first is that in which mixing and aeration take place together and by means of a fast revolving impeller, these being known as mechanical machines; the second, in which the fine division of the air is accomplished by forcing it through a porous bottom, the mixing having previously taken place in a separate vessel, these being the pneumatic machines; and the third, a machine wherein after separate mixing aeration takes place by the entrainment of air as the pulp falls from one separate vessel to another, these being cascade machines. Of the above three types the mechanical floation machine is the widest applied.

Handling the Froth Concentrate.—The froth which overflows is bubbly, sticky and voluminous. It requires breaking down, and this is effected by playing water in jets upon it. Sometimes, to assist disintegration, a little of the oil employed in the treatment is added. When the pulp has to be raised to be dewatered. disintegration is also promoted by commotion in the elevators. The resultant pulp generally contains 7–10 per cent. of solids, most of which, as a rule, is finer than 200 mesh. The bubble system being broken, and the mineral particles having regained their freedom, it becomes necessary to separate the water and to obtain the concentrate in a suitably dry condition for transport and either smelting or extraction by other methods. This is accomplished by either intermittent settlement and decantation, or thickening followed by filtration. Any further removal of moisture is accomplished by draining and drying. Smelters penalise concentrates which contain much moisture. The latter is usually brought down to at least 10 per cent., and sometimes as low as 6 per cent.

Application and Results.—Flotation first established itself by the recovery of blende from an association with heavy gangue at Broken Hill, New South Wales, its success being complete about the year 1910. At Broken Hill, whereas with water concentration before the advent of flotation the recovery was only 60 per cent. of the lead, less of the silver, and none of the zinc, the recoveries to-day are about 85 per cent. of the lead, 65 per cent. of the silver, and 83 per cent. of the zinc. These percentages do not include the lead in the zinc concentrate, nor the zinc in the lead concentrate. The cost of flotation is about 6s. per ton, and that of complete dressing about 9s. per ton. At the Butte, Superior, Montana, the present recovery is about 92 per cent. from an ore assaying about 17 per cent. of zinc, flotation being responsible for about three-quarters of the production.

At Anaconda, where in 1915 the recovery by water was 78 per cent. (the best practice hitherto recorded), a flotation equipment was erected in the expectancy of raising the recovery to over 90 per cent. This expectation has been realised. At Utah-Leasing, Newhouse, Utah, a tailing dump containing about 700,000 tons, assaying about 0·7 per cent. of copper, was successfully treated by flotation, the concentrate assaying about 18 per cent. and the final tailing about 0·2 per cent. At Calumet and Hecla at Lake Superior, the slime resulting from the stamp crushing, a conglomerate of ore containing native copper, is treated by a flotation plant having a capacity of about 2000 tons per day. From this material, which contains less than 1 per cent. of copper, a recovery of 60 per cent. is made at a cost of about 10d. per ton.

EXTRACTION.

The finely divided concentrate obtained by flotation cannot be smelted in a blast-furnace. One of the principal consequences of the development of the flotation process has been the necessity of designing a new type of furnace to deal with these concentrates. This has been developed from the original small reverberatory furnace used many years ago in copper smelting in Swansea. The modern furnace, however, is so much larger and its method of working so different that the process is really a new one.

In this furnace the fuel and ore are kept separate, the former being burned in a separate compartment, from which the flame and hot gases pass over the ore, being guided in their course by a more or less horizontal roof. The heating of the ore is accomplished by the radiation from the roof and side walls rather than by direct contact with the hot gases.

It is particularly suitable for fine materials on account of the relatively quiet atmosphere due to the absence of blast, and there are greater opportunities for the settlement of dust than in the blast-furnace. As the furnace atmosphere is neutral, or very nearly so, it has little or no influence on such reactions as occur in the furnace, and it therefore follows that the reverberatory is purely a melting furnace.

Its functions are that it should melt down ore and flux as rapidly as possible with a minimum of heat loss. It should permit the formation of matte and slag from the mixture of oxides, sulphides, and sulphates in the charge; and the temperature must be sufficiently high to render the matte and slag perfectly fluid in order that there may be complete settling with a minimum loss in the slag.

For rapid melting it is necessary that there should be a good draught, in order that the great volume of gases, which are cooled down by their contact with the roof, walls and charge, is replaced as speedily as possible by fresh, hot gases. Unless this condition holds, there will result a serious reduction in the tonnage that the furnace will handle.

To provide the required heat for the melting, the fuel must be burned as fast as possible. In all modern practice pulverised coal or oil is used, and there must be sufficient burner capacity to produce the required number of heat units per minute.

The heat losses are kept at a minimum by the elimination of side-door charging with its consequent admission of large volumes of cold air. The walls and roof are made as thick as economically possible to reduce the radiation losses; a deep bath of molten material is kept on the hearth continuously instead of tapping the entire contents of the furnace and recharging with cold material as in the early methods of operating. The cold charges of the early smelters required a very large part of the furnace time to heat up and bring to the point of fusion, the actual operation of smelting occupying but a small proportion of the time. The cold material formed a blanket on the top of the charge through which the heat penetrated with difficulty, and it was necessary to stir the semi-fused mass frequently in order to prevent it from sticking to the bottom. In practice the bath of molten material is highly superheated, and readily gives up its heat to the fresh charges which are made frequently and in small amounts.

The heat of the gases is utilised to the greatest possible extent by making the furnace as long as will permit the charge being kept in a fluid condition without an excessive consumption of fuel, and such heat, which necessarily leaves the furnace as sensible heat in the waste gases, is, to a large extent, recovered by passing them through waste heat boilers.

Modern practice demands that the reverberatory charge should be pre-heated. As the fine ores which form the bulk of the charge usually have to be roasted, the resulting calcine is delivered at the highest possible temperature and the flux is frequently added to the roasters. The charge is introduced into the furnace through charge holes in the roof. These are frequently water cooled and are usually situated along the side walls for about half the length of the furnace. The object of charging along the side walls is to keep them covered with the charge, and thus protect them from the action of the hot gases. The usual charge is about 10 to 15 tons at one time, and as this is introduced into the furnace, it floats and spreads out on the bath of molten material on the hearth. The highly superheated bath readily gives up heat to the fresh charge, and it receives further heat from the radiation from the roof and quickly melts.

The resulting slag and matte now move towards the tapping end of the furnace and have ample time in which to separate cleanly. The slag may be tapped intermittently or allowed to flow off continuously. The latter is coming more into favour, as it results in cleaner slags. The matte is tapped from the fore part of the furnace, as required by the demands of the converters in a manner similar to tapping a blast-furnace settler.

The reverberatory furnace is the most satisfactory

* The thirty-third James Forrest Lecture delivered at the Institution of Civil Engineers, May 3rd, 1927.—Condensed.

and advantageous apparatus in which to treat fine ores, but it usually requires an extensive roasting plant, occupies a large amount of space, and locks up a large amount of valuable metal. Hence the investment is large for a given tonnage. While large amounts of low-priced fuel are used, a large proportion of the heat in the gases is recovered in waste heat boilers, and this greatly reduces the power cost. The amount of slag, and, consequently, the metal loss, are less than with the blast-furnace. With the ever-increasing amount of fine ores to be treated, the reverberatory furnace is fast displacing the blast-furnace, and it has even been found advantageous in certain localities to use reverberatory smelting for coarse ores that under ordinary conditions would go to the blast-furnace.

Hydrometallurgy.

On account of the finely divided condition of most flotation products, it is not always possible to treat them by hydrometallurgical methods economically, but with improved methods of agitation and filtration it is probable that much greater use will be made of wet methods of extraction in the future. Hydrometallurgy offers an effective solution of the problem of high shipping and refining costs, and it appears probable that the treatment of these concentrates will eventually follow on the lines of roasting, leaching and the electrolysis of the solution so as to obtain the metal and regenerate the electrolyte.

Twenty years ago there were but few wet metallurgical processes in operation on a large scale, and these were mainly for the extraction of gold, silver and copper. The more important were the cyanide process for gold and silver and the Henderson and Rio Tinto processes for the extraction of copper. Whereas at that period a profit could not always be assured with a gold ore containing 4 dwt. per ton of ore, it is now possible to treat one containing half that amount of gold under similar circumstances. At the present time silver ores begin to be of commercial importance when they contain about 100 parts per million, or 3 oz. per ton. When associated with commercial ores and copper and lead, they are extractable at negligible cost, and in such cases smelters usually pay for over 0·025 oz. of gold and 1 oz. of silver. Under favourable conditions, a gold deposit may now be profitably dredged which contains only one part in 10 million, or 3d. value of gold per ton.

Copper has been extracted from its ore by heap-leaching methods in Spain since 1752, but these ores contain from 2–3 per cent. of the metal. This process is actively in operation at the present time, and, as the pyrite itself is barely attacked, it is sold for its sulphur value after the copper has been extracted. With modern methods, it is economically possible to treat ores containing much smaller quantities of copper. In the spring of 1923 the Ohio Copper Company of Utah commenced the leaching of an ore which averages only 0·3 per cent. of copper, and which has since proved to be a profitable undertaking. It consists of a copper-bearing quartzite in which the copper minerals exist principally in the fissures. The quartzite is practically inert to chemical action, while the copper minerals are readily attacked by the leaching solution. At the Calumet and Hecla mine an old tailing containing only 6 lb. of copper per ton—0·27 per cent.—has been successfully treated by an ammonia process. It has been estimated that about 15 per cent. of the copper output of the world is now produced by leaching, and two of the largest of such plants in operation at the present time produce copper at a considerably lower cost than by any other method of treatment.

The leaching of copper and silver ores is now in a similar position to that of gold and silver cyanidation, and especially in the case of copper ores the process and plant used have followed very closely those employed for cyanide work. Since 1905 processes for the wet extraction of zinc and lead have been developed and will probably in a few years become formidable rivals to smelting methods, while already the wet metallurgy of zinc is of considerable economic importance. Lead leaching at the moment has not attained so favourable a position as copper and zinc, and there is room for much further research in this direction.

For the past fifty years it has been known that zinc can be deposited from its solutions by electrolysis, but attempts to apply this knowledge on a large scale as a method of producing zinc from its ores were not successful until 1914. In that year the Anaconda Copper Mining Company and the Consolidated Mining Company at Trail, B.C., initiated independent investigations on the treatment of complex ores occurring in their respective districts. Both were sufficiently successful to justify the erection of small test plants which were rapidly enlarged to meet the demands for high-grade zinc required in particular for cartridge metal during the war. To-day the capacity of the Anaconda plant at Great Falls, Montana, is 300 tons slab zinc per day; that of the C.M.S. Company at Trail is 200 tons per day, while that at Hobart, Tasmania, for the treatment of concentrate from the Broken Hill Mines is 150 tons per day. At the present time these three plants produce practically all the electrolytic zinc of the world. They all use sulphuric acid leaching followed by electrolysis of the zinc sulphate solution with a current density of about 30 ampères per square foot of cathode surface. The success of this process is dependent upon the use of an electrolyte of a very high degree of purity. The reason for the failure of the earlier processes which used the same method of leaching was due to a lack of appreciation of this fact.

The Electric Refining of Steel.

Twenty years ago the manufacture of steel in the electric furnace was still in the embryonic stage. To-day more than 1200 such furnaces are in operation in Europe and America (including Canada), in about equal numbers in the two continents. In the decade 1910–20, the advance of what may be called "electric steel" has been phenomenal. It increased from 52,141 tons in 1910 to 502,152 tons in 1920. In 1925 1,042,000 tons were produced, of which the U.S.A. was responsible for 615,000, Italy 129,000, Germany 127,000, France, 68,000, and Great Britain 44,000. The principal use of such furnaces has been in producing alloy and tool steel ingots and castings.

Experimentation during the years 1900–15 resulted in the restriction of the types of electric furnace to four—the indirect arc, the direct arc with a non-conducting hearth, the direct arc with a conducting hearth, and the induction. Of these experience has shown that the two most generally used are the Héroult (the direct arc with a non-conducting hearth) and the Girod (the direct arc with a conducting hearth).

The refining of steel involves both oxidation and reduction processes. The first advantage of the electric furnace is its flexibility. It can be successfully operated with cold charges or with hot metal. It can be used for castings, for making pig iron synthetically, and for refining molten cupola iron. The temperature can be controlled within a few degrees. Both oxidation and reduction can be carried to any point desired, and the two impurities always present in iron and steel, which it is so desirable to eliminate, namely, sulphur and phosphorus, can be reduced below the amounts which are possible in the open-hearth process. It is claimed that the electric process is the only commercial steel-making operation which will first of all oxidise thoroughly and then deoxidise completely, reducing sulphur to not more than about 0·01 per cent.

The second advantage consists in the method of applying the heat. This is generated exactly where it is most necessary, namely, in the charge itself. Local overheating is thus prevented, or, at any rate, largely minimised. Moreover, a higher temperature can be reached and maintained than in the fuel-fired open-hearth furnace. This facilitates refining, permits reactions to become completed in a shorter time, and, most important of all, permits the use of very basic strongly reducing refractory slags.

The third advantage consists in the quality of the product. It is claimed that, given proper handling, the process produces steel equal in every respect to the best crucible steel. It is claimed further that compared with steel made either by the Bessemer or open-hearth process, electric steel has greater density, can be made free from blow-holes, slag and occluded or absorbed gases, and is stronger, tougher and more ductile. One of the special features of the process is the fact that the steel can be and is made entirely in the furnace. All additions of alloys are made directly to the bath. This results in a well mixed steel, since all the furnace additions have sufficient time allowed for their melting and thorough mixing.

The outstanding disadvantage of the electric process is its cost. It may be expected that with the continual improvement in efficiency of power production plants, this disadvantage will tend to become less and less. Another factor which will operate in the same direction will be that economies of furnace operation will be more thoroughly understood and practised Another disadvantage from which the furnace has suffered more or less hitherto is that it has been operated by men unfamiliar with its possibilities. To some extent the view has prevailed that electric steel occupies a field midway between acid and basic open-hearth steel and crucible steel. This, of course, is not the case. As already stated, the quality of electric steel is fully equal to that of crucible steel and can be achieved provided refining is properly carried out metallurgically. Hot metal electric furnaces are nearly always operated in conjunction with a large open-hearth plant, in some cases as the final operation of a three-furnace process (Bessemer, open hearth and electric) commonly known as the triplex process. With proper operation, the product is sufficiently good to have warranted both German and American railways paying a higher figure for steel made by this process. It is important to remember, in electric steel-making, that desulphurisation does not necessarily guarantee deoxidation, but that deoxidation does guarantee desulphurisation. With the passage of time a body of younger men is gradually becoming versed in electric steel refining, and it is to be expected that the quality of the resulting metal will be still further improved.

Quality in Ordnance Steels.—The attempts of the manufacturers in the United States of America to produce a high-grade product for army and navy ordnance were so unsuccessful and the resulting steel so unsatisfactory that the United States Government in 1918 appointed a Committee of the foremost metallurgists of the country to investigate melting practice. Their results were published in a paper, entitled "Acid Open-hearth Process for the Manufacture of Gun Steels and Fine Steels." The sum and substance of the paper, boiled down to a few words, was that to make good steel it must be deoxidised. The United States Government has constructed an armour plate and gun factory at Charleston, West Virginia, where electric furnaces are used exclusively in ordnance steel manufacture. Experiments have been carried out at this plant for more than a year, and show that the electric process produces ordnance material in weights up to 100 tons superior to acid open-hearth steel and much superior to basic open-hearth steel of like composition.

Tool steel of the highest grades, both carbon and alloy steels generally, are now made by the electric process. Certain makers of motor cars specify electric alloy steel almost exclusively. The principal units are 6-ton and 30-ton furnaces, but it is quite customary to overload the 30-ton at least to 40 tons.

"Pearlite" Cast Iron.

The high-carbon iron-carbon alloys solidify "white" unless a particular stimulus is present to cause the precipitation of graphite. They consist accordingly of cementite and pearlite. Since "white" iron is so hard as to render it incapable of being machined, its use is greatly restricted in mechanical engineering work. The addition of silicon, however, causes the formation of free carbon from such a white iron, and it is possible, in certain favourable conditions, including slow cooling, to produce a cast iron consisting only of silico-ferrite and foliated coarse graphite. Such a material is very weak, although soft, and apart from a few special cases such iron is but little used for mechanical engineering work. Between these two limiting conditions come the usual technical kinds of grey iron. Their microstructure depends on the smelting and casting processes used, the conditions of solidification and cooling after casting, and upon the chemical composition. The rate of cooling is, of course, considerably affected by the cross-sectional area of the particular casting. In the microstructure of ordinary grey iron are usually found together varying quantities of graphite, silico-ferrite, pearlite, free cementite and the phosphide eutectic, together with inclusions of iron and/or manganese sulphide.

A carbon steel containing 0·9 per cent. of carbon consists, when annealed, only of eutectoid pearlite, the structure being uniform and dense. This material is pure steel. It has, as is well known, very remarkable mechanical properties. The problem of improving the qualities of cast iron consists essentially in preparing a material composed mainly of pearlite with deposited graphite. A cast iron of this kind would certainly be superior in properties to any of the ordinary varieties, and it might be expected to exhibit mechanical properties approximating to those of pearlitic steel, which would be influenced only by the graphite. Numerous tests carried out by different investigators on castings approximating to the above structure bear out this view. It was at first not found possible to get the desired structure in current practice. Diefenthaler and Sipp were, however, able to devise a process to enable this structure to be obtained regularly. It was patented in 1916. It has been improved upon, and has finally led to very definite rules for achieving the desired properties.

It consists essentially in the proper regulation of the furnace charge and the correct heat treatment of the moulds. Correct mixing is intended to give as little stimulus as possible to the formation of graphite. The materials used are carbon, silicon and low phosphorus pig iron. It is also a remarkable fact that a high sulphur content, which most foundrymen fear more than anything, does not appear to be detrimental to pearlitic cast iron. When cooled in the ordinary way, an iron of this kind would solidify "white." In order to produce the desired pearlite-graphite structure, a slow rate of cooling is necessary, and this is obtained by pre-heating the mould. The degree of pre-heating depends, of course, upon the wall thickness of each particular casting. Theoretically speaking, it should be possible to get from one and the same charge and by suitable heat treatment of the mould, every desired cross-sectional area with the same final product—pearlite-graphite structure—when once the rates of cooling for the different cross-sectional areas have been determined. In practice, various cross-sectional areas are grouped together and a special burden or charge selected for each group, assuming the same amount of pre-heating of the mould.

The properties claimed for the cast iron are—(1) High transverse and tensile strengths and toughness; (2) high resistance to impact stresses; (3) moderate hardness when properly treated; (4) only a slight tendency to the formation of "pipes," and hence the possibility of making complicated castings; (5) great resistance to sliding friction (abrasion); (6) fine and dense structure, the structure being unaffected by temperature changes.

(To be continued.)

The Belgian Cabinet has decided to ask Parliament for the necessary funds to replace the existing mole at Zeebrugge by one built on arches.

RAILWAY AND URBAN IMPROVEMENTS AT PICCADILLY CIRCUS

MR. H. H. DALRYMPLE-HAY, M. INST. C.E., LONDON, ENGINEER

(For description see opposite page)

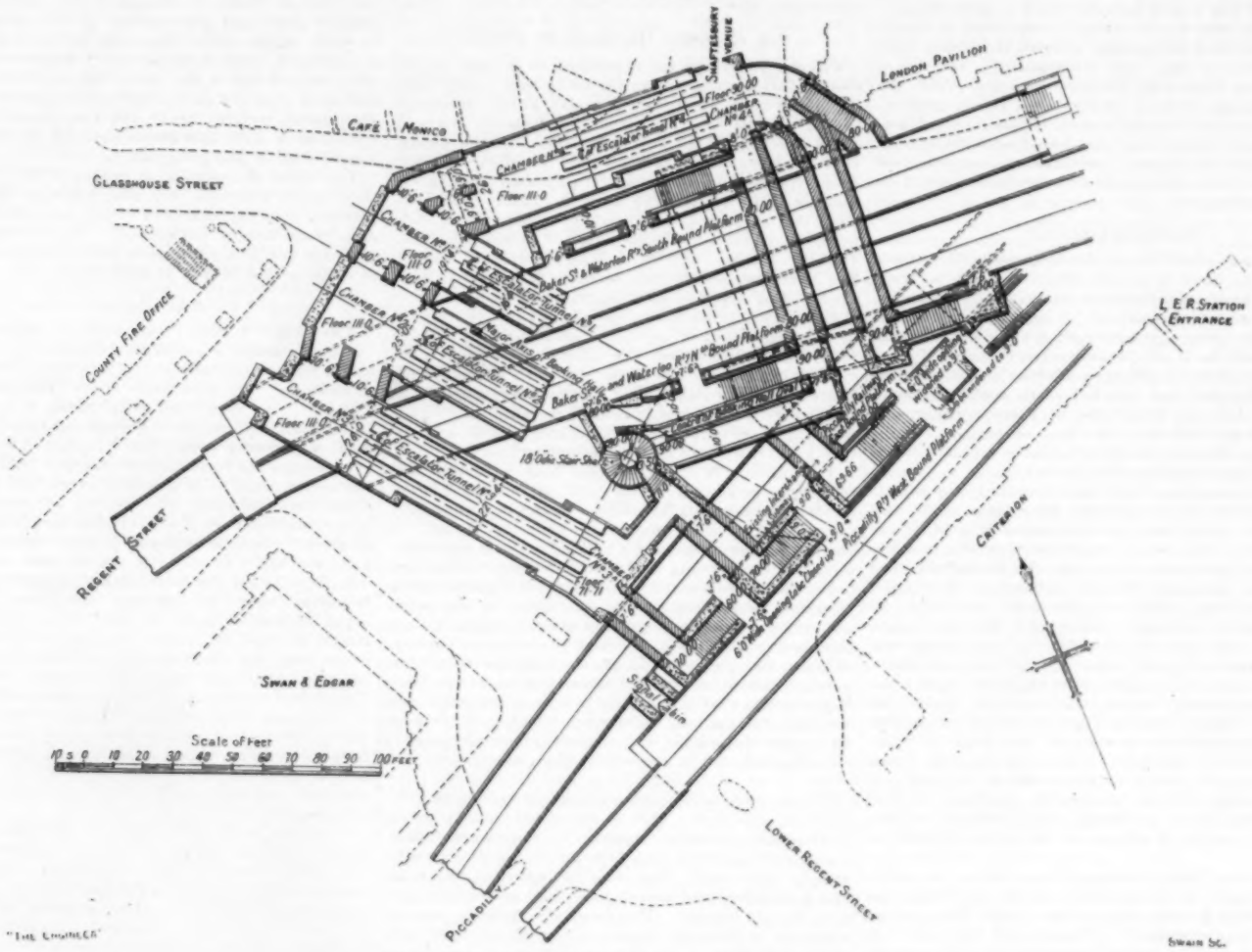

FIG. 6—PLAN OF ESCALATOR TUNNELS AND CHAMBERS

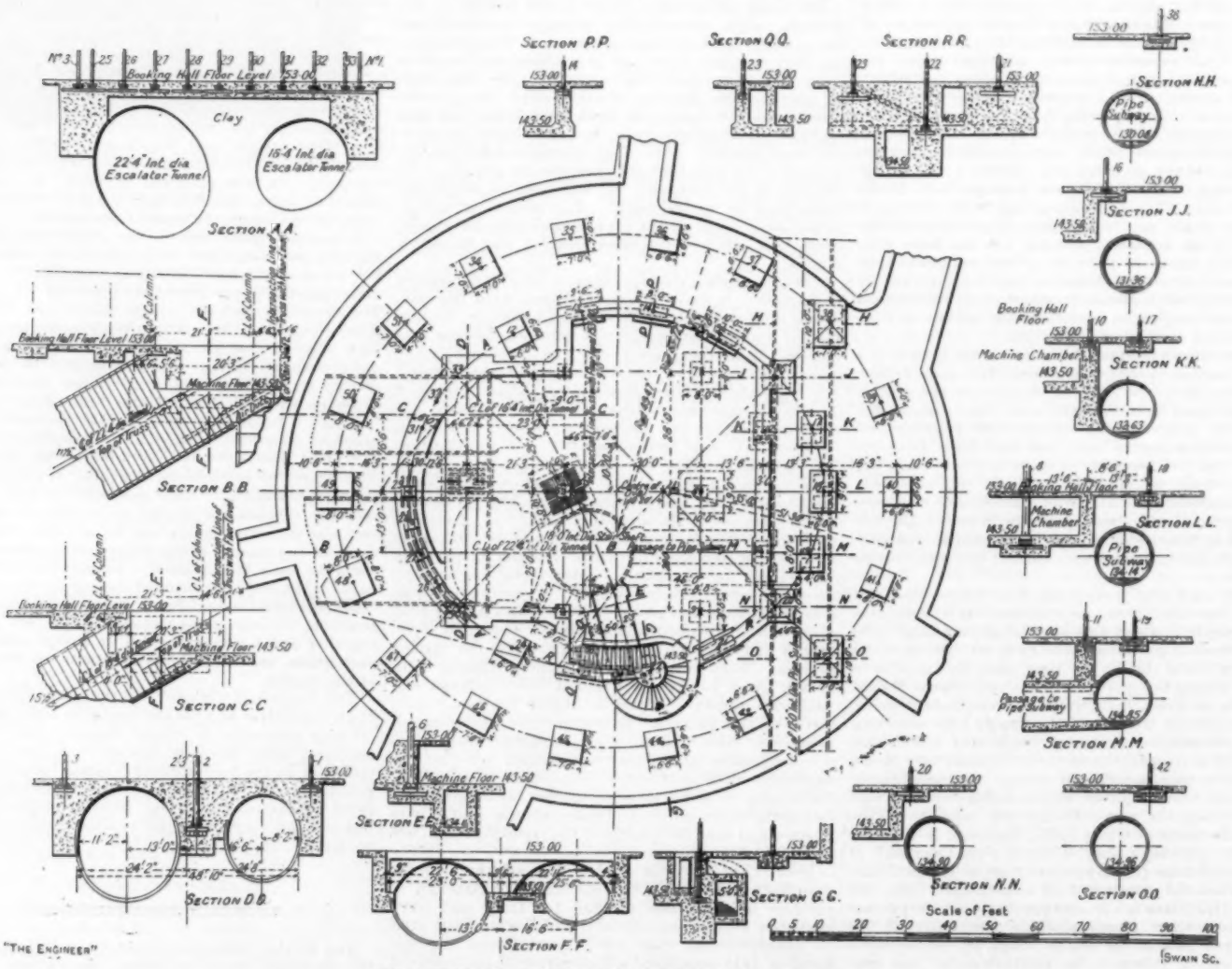

FIG. 7—PLAN OF BOOKING HALL, AND VARIOUS SECTIONS

The Railway and Urban Improvements at Piccadilly Circus.

No. II. (*Conclusion*).*

CIVIL ENGINEERING ASPECTS OF THE WORKS.

CONSIDERED as a civil engineering work, the main feature of the undertaking is, of course, the construction of tunnels, lined with cast iron, in the blue clay. The booking hall, passenger subways and pipe shafts will be constructed in the layer of gravel 20ft. or so in thickness, which overlies the clay, and it is in this gravel and in the made ground of the streets that the pipe interceptors are being excavated and built. The work now proceeding includes:—These excavations and the building of their brickwork walls, on concrete foundations and floors, beneath the temporary bridges of rails and concrete already described; the building of the rectangular chambers which form the junctions between the several parts of the pipe subway and between that subway and the pipe shafts which connect it with the pipe interceptors; the construction of the escalator tunnels and of the large escalator chambers, shown in Fig. 6; and the driving of various headings, some temporary, for the removal of spoil or for purposes of communication, others permanent, or to be developed into permanent passages in the future system of underground ways.

Much of this work is already done, and the emergency stair shaft, without the stairs, is completed. Reverting, for the moment, to the gravel layer, it may be noted that while most of it was found to be dry, water was encountered at a number of places, no reason for its presence in one spot or absence from another having been found. The blue clay is a homogeneous mass of that well-known material. At the lower depths it is of almost rock-like consistency.

In the course of the excavations, various interesting objects have been found in it, including fossil timber and fossil shells of species of Nautilus, which still possessed the mother-of-pearl sheen of the original shells.

METHOD OF EXCAVATION.

The general procedure is to place all the rings of the cast iron lining as the work proceeds, regardless of the positions of future chambers, headings or connecting passages, and to plank up and grout every working face or other opening when it has to be left, pending further operations. Any movement of the clay or diminution of its volume, tending to settlement overhead, is thus avoided. The spoil is loaded into skips which, where the excavation is at the lower levels, are hauled up the escalator tunnels by means of electric windlasses. They are then pushed by hand to the central shaft, where they are lifted by a crane mounted on a timber platform in the works enclosure near the middle of the Circus. Here the spoil is dumped into a large hopper which spans a lorry bay, accumulating in this hopper during the day and being dropped, during the night, into lorries which enter the bay underneath it by the north side of the hoarding and pass out at the south side. Thus, the inconvenience which would be caused by the continual arrival and departure of the spoil lorries during hours of busy traffic is avoided. The work is carried out by day and night, continuously, the clay faces being supported by timbering while the iron lining is being built in.

In the driving of the tunnels, free use is made of the methods of successive enlargements. This method adds to the security of the operations, facilitates the sealing up of exposed surfaces, and by reducing the volume of spoil withdrawn at one time, per foot or per day of advance, it lessens the chances of settlement of the clay overhead. The smallest of such tunnels is that driven by means of the "Novelty Heading," as it is called by the engineers, in which only four of the elements or segments of a tunnel ring are used, abutting on four oaken keys. For the purpose of making temporary connecting passages or for the heading for a permanent narrow passage, a heading in which there are only two elements of a cast iron ring is sometimes employed. These form the sides of the heading, the top and bottom being baulks of timber strutted by other pieces of timber within the curves of the cast iron elements. As an example of successive enlargements we may note a case in which a tunnel 8ft. 6in. diameter was first driven, this being replaced, first by a 14ft. tunnel and finally by the permanent tunnel 22ft. diameter. A similar case is that of chamber No. 3 at the top of escalator No. 3, the position of which is shown in Fig. 6 and details in Fig. 8, sections C C and F F. Section A A shows the alignment of the "Novelty" heading, in relation to the centre line of the permanent 22ft. 4in. diameter tunnel; also the position of the temporary 14ft. tunnel in relation to the 26ft. diameter chamber by which it will be replaced. The two 10ft. 6in. openings lead to chamber No. 1, giving access to chamber No. 4, at the head of the escalator No. 4, leading to the platform of the Bakerloo line. In the other direction access is given to the Piccadilly line.

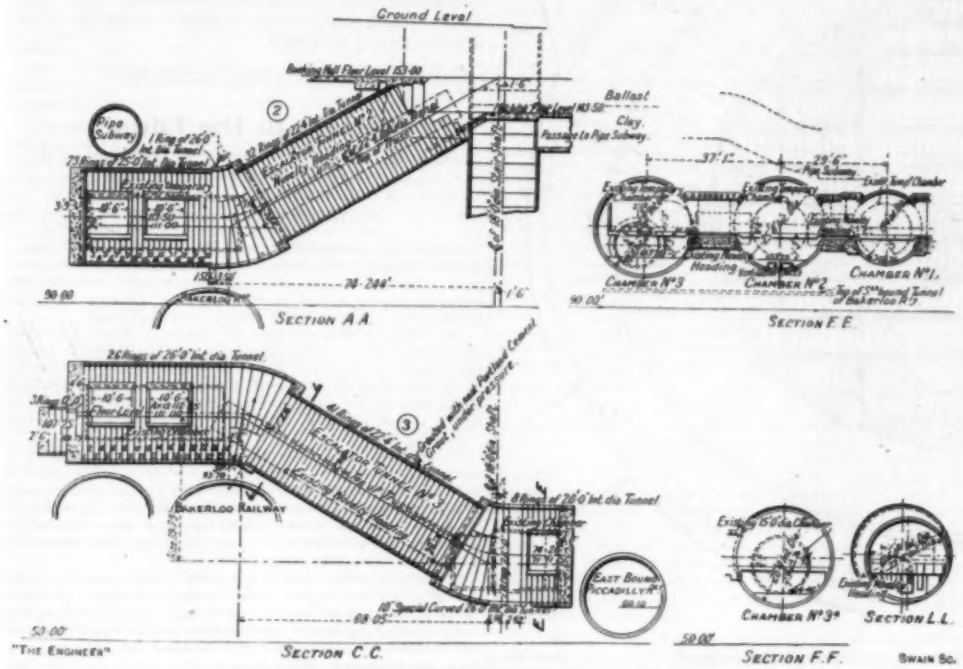

FIG. 8—SECTIONS OF ESCALATOR TUNNELS AND CHAMBERS

MAIN STRUCTURAL FEATURES.

In designing the various junctions between different parts of the system of communications the consulting engineer has adopted, in every case, the method which seemed to be economical and stable, having regard to the particular dimensions of the adjacent structures and the angles involved. Thus, in Fig. 8, section A A, the provision of a few steel joists imbedded in concrete is the only accessory work needed for the junction of the machinery floor, the central shaft and the escalator tunnel, here reduced to a few elements of its rings, while the last of the complete rings of this inclined tunnel is received in the concrete of the booking hall floor. This is also shown in section B B, Fig. 9, and similar connections are to be seen in section C C, Fig. 7. At its lower end, the escalator tunnel requires concrete walling to adapt the 22ft. 4in. diameter to the 26ft. diameter radial rings which, in turn, effect a self-sufficing junction with the 25ft. rings of the chamber.

In Fig. 9, though a concrete wall is used at the lower end of the escalator tunnel, the diminishing number of elements in the incomplete terminal rings enables an almost iron to iron junction to be effected.

Fig. 6 shows clearly the general disposition of escalators, chambers and passages. Chambers 1, 2 and 3 are connected by passages having concrete floors and walls and roofed by steel joists imbedded in concrete. The junctions with the chambers are made by removing the necessary numbers of ring elements, eight in each of these cases, and introducing girders at the tops and bottoms of the opening so formed, and stanchions at the sides, as shown in Fig. 8, section E E. In all cases of the cast iron ring work, the horizontal joints, being stressed by the forces set up by the pressure of the clay, have been machined, the circumferential joints being packed with wooden strips.

SOME DETAILS.

The work of lining the tunnels is completed as it proceeds by the grouting with cement of the small space left between the iron and the clay, similar grouting being also done in the case of temporary timbering and planking placed to support the working face before the iron segments are erected. The grouting machine has a container of a simple form into which air is forced by means of an air compressor installed on the surface within the works enclosure. When making connections involving the opening of a part of a provisionally complete tube, the usual procedure is to remove two rings, excepting the elements in the crown.

In the pipe subways rings of specially heavy section are used wherever the subway passes close underneath the bases of stanchions in the booking hall or lavatories. At one point, where the tunnel is only some 18in. below the floor level, the normal elements, it was noted, had been replaced by thicker and more heavily flanged pieces. As a further precaution a grillage is provided, over the crown of the tunnel.

The taper elements used at bends are not developed to the full width of divergence starting from the narrow end of the radial slice of the curved tube, but are so dimensioned that the wide end—longitudinal edge—of one element is just double the width of each of the abutting edges of the two elements succeeding it, these preserving the radial form, that is, not breaking joint transversely to the tunnel. Very nice calculation has been necessary in the case of combined bends where the changes of direction are sometimes very sharp. At one place, for instance, where a sharp bend to the left is succeeded by an upward bend, only one normal or cylindrical ring intervenes.

THE BOOKING HALL.

The structural features of the booking hall design are of a normal kind, and are shown in Figs. 7 and 10. The outermost ring will be a concrete wall, curved to radii, such as 62ft. and 75ft., some diameters of the roughly oval area being 144ft., 135ft., 130ft. and 128ft. The wall is pierced by five subway entrances. About 10ft. within this rough oval is the oval formed by the outer ring of columns, eighteen in number, and about

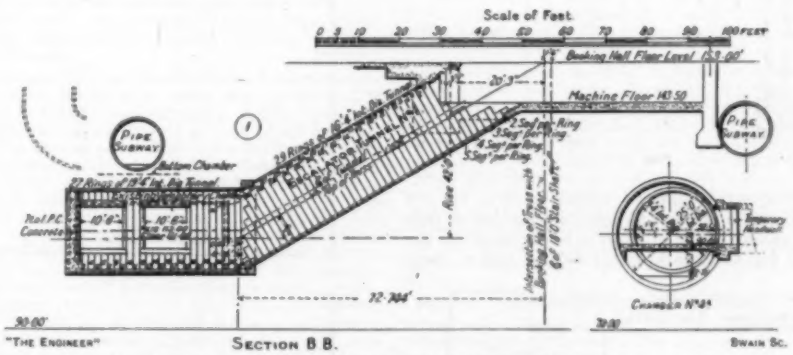

FIG 9—ARRANGEMENT OF ESCALATOR TUNNEL NO. 1

form of the Bakerloo line. In the other direction access is given to the Piccadilly line.

MAIN STRUCTURAL FEATURES.

In designing the various junctions between different parts of the system of communications the consulting engineer has adopted, in every case, the method which seemed to be economical and stable, having regard to the particular dimensions of the adjacent structures and the angles involved. Thus, in Fig. 8, section A A, the provision of a few steel joists imbedded in concrete is the only accessory work needed for the junction of the machinery floor, the central shaft and the escalator tunnel, here reduced to a few elements of its rings, while the last of the complete rings of this inclined tunnel is received in the concrete of the booking hall floor. This is also shown in section B B, Fig. 9, and similar connections are to be seen in 21ft. apart, the space thus begirt measuring nearly 124ft. by 110ft. About 16ft. within this ring is the inner ring of columns, forming the boundary of the enclosed area, an oval nearly 90ft. by 80ft. There are eighteen columns corresponding radially with those of the outer ring, and over the last few complete rings of escalator No. 2 and the neighbouring area—Fig. 8, section A A—there are four intermediate columns which halve the local pressures. Here, as in other places where there are structures immediately beneath, the column footings are especially large in area. In this oval there are ten columns and thirteen main girders of various lengths up to 26ft. The secondary girders have spans of about 30ft. in the middle row and smaller spans elsewhere. The usual distance apart is 6ft. 6in., which is, therefore, the overall span of the joists. The joists between the inner and outer rings of columns and between

* No. I. appeared April 29th.

the latter and the encompassing wall are in groups parallel for each pair of girders, the radial gaps being provided with short joists parallel to the girders.

THE BUILDING OF THE CHAMBERS.

The method adopted in building the chambers is in accordance with the general policy of avoiding to the utmost any depletion of the surrounding mass of clay. Also, especially when building the large chambers at the feet of the escalators, important quantities of extra concrete would have to be put in if there were any considerable excavations or falls of clay in excess of the volume to be replaced by the structure; for the conditions make it highly inexpedient to attempt any kind of refilling. The method varies in details according to the shape and dimensions of the structure and other conditions, but it may be described as for a typical case as follows.

Taking, as an example, of a tee junction, the chamber No. 3 at U in Fig. 3 *ante* and using also Figs. 11 and 12, we note, first, that the pipe subway originally extended unbroken across this site while the pipe shaft V P was brought nearly up to the edge *h g* of the square later occupied by the foundations of the chamber.

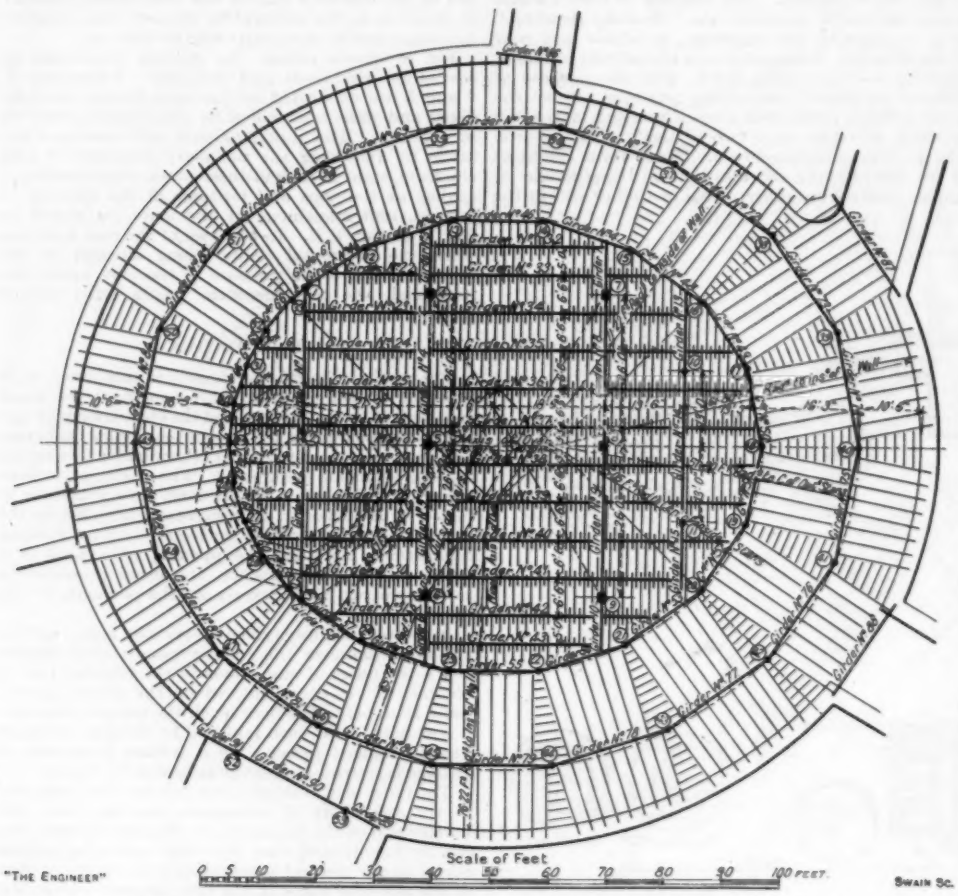

FIG. 10—ARRANGEMENT OF GIRDERS AND JOISTS IN BOOKING HALL ROOF

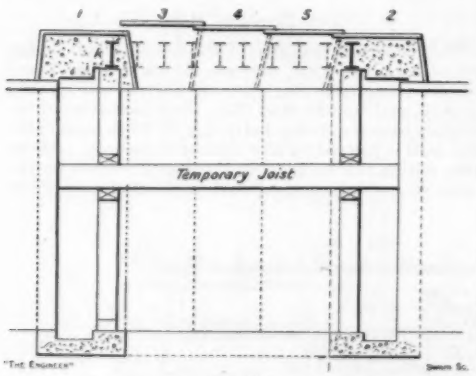

FIG. 11

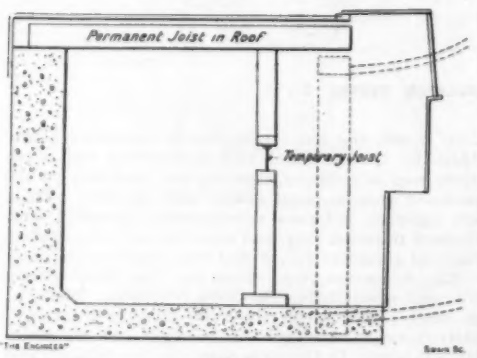

FIG. 12

The side *e f* will eventually be a blank wall, and the other three sides pierced walls. The procedure is illustrated by Figs. 11, 12 and 13. The first operation is to remove two rings to the right and two to the left, near the lines *g f* and *h e*. This makes it possible to put in the two ends of the foundation and to build, at the four corners, portions of the walls up to the roof level, as shown under 1 and 2 in Fig. 11. The recesses in the foundation and the absence of joists in the concrete overhead indicate that the rings of the two abutting ends of the subway tube will be, not restored, but replaced by rings of heavier elements, as far as the concrete on which rests the sole plate of the timber post. As soon as the work has been done

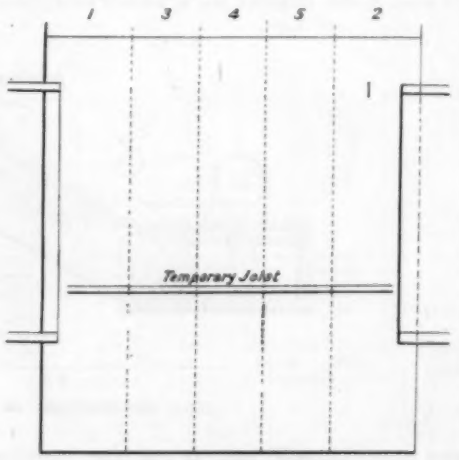

FIG. 13

to the limits of 1 and 2, Fig. 11, and the concrete has hardened, the timber posts and the temporary joist are put in position, and, at each end, one permanent roof joist is put in place, one end of it resting on the portion of the blank wall already built and the other supported by its post; and similarly at the other end. Next, the rings in the portions 3 and 4 are removed, the floor and the blank wall put in as far as this allows, and the permanent roof joists set in position as in the previous case and boarded over to hold up the overlying clay. The same operation having been carried out with section 5, the blank wall is now complete up to roof level, the joists rest upon it, their other ends projecting over the temporary timber props, awaiting the support to be given by the end of the pipe shaft and the pierced wall. The end of the pipe shaft, being close at hand, has merely to be cleaned up, the necessary number of rings, made of the extra strong elements, being added to it. The wall can then be completed around it, enclosing the ends of the joists, and, the ends of the pipe subway having been similarly completed with the extra strong rings, it only remains to concrete in between the roof joists and to grout up every cranny tightly. The roof boards are removed when possible, and the space left by their removal grouted. In any case grouting is applied. The chamber is then complete except for the internal finish.

To some minds the strongest impression left by visits to the works in progress and a study of the plans is that the surveying and levelling necessary for the planning of the works, and the setting out operations, perforce executed piecemeal, must have involved and continuously demand operations of the greatest nicety and skill.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

"THE MEN WHO DO THINGS."

SIR,—While sympathising with Mr. Frank Richard's pæan of praise for a hardly dealt with and underpaid profession, a sense of justice compels me to find the engineer none the less intensely human and in no way superior, humanly speaking, to his brother professional of church, medicine, or law.

One readily admits also both the bridges of America and the great rivers, which accord opportunities to the American bridge builders; it is the irony of Fate that one of those rivers should, at the time when Mr. Richards' article is being read on this side of the Atlantic, be demonstrating with the utmost lucidity that rivers, as well as the men who seek to control them, can also "do things."

Possibly the lesson of the Mississippi is that one can interfere too far with Nature, and so far as this country is concerned, it is wiser for us to water dry areas artificially abroad, than to seek to get cheap power at home by meddling with that comparatively "small brook" the Severn, which has, after all, a substantial width and tide problems all its own, involving silting and allied difficulties.

In short, to develop coal at home and Colonies abroad should provide a better "slogan" than "cheap electricity," so far as Great Britain is concerned. That thought is prompted by the extraordinary importance our American friends attach to either size or novelty in their own land. We need not, however, envy them the magnitude of the present flood, which is all the less to the credit of their foresight in that the Mississippi has been under riparian observation for some 200 years. No; all things considered, I think the engineer, whether in the New or Old World, is still capable of errors; the only wonder is that he makes so few.

S. P. CHRISTIE.

Leeds, May 4th.

THE SENATE OF THE UNIVERSITY OF LONDON.

SIR,—On May 10th Graduates in Science of the University of London, who are Members of Convocation, will elect three Graduates to fill vacancies among the five Convocation Members of the Senate who represent Science. Owing to the considerable and growing number of Engineers who have taken a Science degree at the University of London, it has long been felt that one of the representatives of Graduates in Science on the Senate should be an engineer in practice. I have been invited by the Council of the Twentieth Century Society of London Graduates to stand for election to the Senate as an engineer, and I wish, if I may do so, through your journal, to ask all Engineer Science Graduates who are Members of Convocation of the University of London, and who are anxious, at last, to be represented on the Senate by a member of the profession in active practice, to give me their votes. The other candidates are closely connected with teaching, and since there are three vacancies, two of them must in any case be returned, so that to secure my election it would be advisable to vote for no other candidate except myself.

ROGER T. SMITH,
M. Inst. C.E., M.I. Mech. E., Past-President I.E.E.,
Vice-President Inst. T.

36, Victoria-street, Westminster, April 25th.

BOOKS RECEIVED.

Dielectric Phenomena. By S. Whitehead. Edited with a Preface by E. B. Wedmore. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price 16s. net.

Abridged Callendar Steam Tables: Fahrenheit Units. Second edition. By H. L. Callendar. London: Edward Arnold and Co., 41, Maddox-street, W. Price 1s. net.

Report on the Economic Situation in Belgium. By J. Picton Bagge. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 4s. 6d. net.

Report on the Progress and Condition of the United States National Museum for the Year Ended June 30th, 1926. Washington: Government Printing Office. Price 25 cents.

Proceedings of the American Society of Civil Engineers, April, 1927. New York: The American Society of Civil Engineers, 33 West, Thirty-ninth-street, U.S.A. Price 1·00 dollar.

The Directory of Contractors and Public Works Annual, 1927. Edited and compiled by C. W. Biggar. London: Wightman and Co., Ltd., 104, Regency-street, S.W. 1. Price 17s. 6d. net.

Water Powers of Manitoba, by C. H. Attwood, A.M.E.I.C., *being Water Resources Paper No. 56 of the Water Power and Reclamation Service of the Canadian Department of the Interior.* Ottawa: F. A. Acland, 1927.

Railway Matters.

THE junction at Old Oak Common for the Wycombe line, used by the Great Western expresses for Birmingham, requires a speed limit of 20 m.p.h. It is now to be improved so as to allow for 40 m.p.h.

ANSWERING a question addressed to him the other day, the Postmaster-General replied that he was aware that broadcast receiving sets had been installed in long-distance trains in some countries. Experiments conducted some years ago in this country showed that it was possible to receive broadcast programmes on trains in motion, but no application had been received for a licence for the permament installation of wireless receiving apparatus in trains.

A PARTY of railway students from Germany has been touring various railways in this country during the present week. The members arrived last Friday, and have been to Southampton, the Chiswick Overhaul Works of the London General Omnibus Company, the Morden Extension, Swindon, Derby, Manchester, Wath Gravitation Yard, York, Edinburgh, and will go to Feltham to-morrow and leave for home in the evening. The visit has been arranged in return for one given to English students last year.

BEFORE the war the Great Eastern Railway was essentially a passenger line, but since then it has greatly developed a goods traffic, which, in 1925, was nearly 20 per cent. greater than in 1913. Little or no capital expenditure had been incurred by the Great Eastern in the way of provision to meet that increased traffic, and thus the London and North-Eastern, which has succeeded to the property, has found very great difficulties in handling the traffic. As a means to secure some relief a traffic control office has been opened at Cambridge.

A SURVEY has been made on the 40 kiloms. section of the Puerto Wilches Railway—on the Magdalena River—from Conchal to Bucaramanga in the Department of Santander-del-Sur, about 227 miles from Bogotá, in Colombia. This line will greatly benefit traffic between the Atlantic Coast and Bogotá, providing an all rail route. A further section of the Northern Railway, 50 kiloms. long, to Puente Nacionál, is about to be commenced, but will take at least four years to complete. This will then form a further contribution to the Puerto Wilches line.

THE overseas mails arriving at Plymouth have hitherto been man-handled between the mail tender and the train, which has required the services of rarely less than 100 men and sometimes from 130 to 150. An electric belt conveyor has now been provided, which requires only one-third of the normal number of men. The belt is 36in. wide, moves at a speed of 160ft. per minute, and has a capacity of 60 tons per hour. The arrangement was the idea of Mr. C. S. Page, the railway company's chief docks manager, and was built at the Fraser and Chalmers' works.

IT now appears that when the deputation from the railway companies and the railway trades unions waited upon the Chancellor of the Exchequer as related herein on April 1st, to discuss the motor competition, the question of passenger duty was also mentioned. As that tax brought £419,525 into the Treasury in 1925, it was only natural that Mr. Churchill should decline to relieve the railway companies of it. The duty is a survival of powers granted in the reign of William IV., which were modified in 1844 as regards passengers conveyed at one penny per mile and less by what were known as parliamentary trains. In 1883, by the Cheap Trains Act, the duty was wholly withdrawn from third-class fares unless it was shown that a railway company was not providing sufficient workmens' trains.

IT is announced that the station at Brighton is to be enlarged. The original station was opened on May 10th, 1840, when the Brighton-Shoreham section of the London and Brighton Railway was put into service. The line from London reached Brighton on September 21st, 1841. The station was 300ft. long and 114ft. wide and was covered by a roof which Sir Frederick Smith, the Board of Trade Inspector of Railways, described as of "elegant design." It was enlarged in 1862 and again in 1883. It has eleven platform roads, but one will hold only rail motor trains. As the official announcement as to the changes now contemplated specially mentions an enlargement of the circulating area, it is reasonable to assume that the buffer stop collision there, mentioned in this column of our issue of November 19th last, has had some influence on the situation, as in the accident report thereon it was shown that the unloading and loading of carriage trucks on Nos. 6 and 7 roads required those lines to be shorter than Nos. 5 and 8 so as not to rob the circulating area.

AN interesting departure in rolling stock for electrically operated trains has been made in seventy-five new coaches built, or being built, for the London, Midland and Scottish Railway for its services in the London area. All such stock, whether used in London or on the Liverpool-Southport or Manchester-Bury services on the former Lancashire and Yorkshire, were of the open car type, but they had compartments, though not with corridors. In support of the change it is claimed that the compartment coaches seat more passengers and that, when the traffic is heavy, they are unloaded and loaded more quickly. The latter point is of interest inasmuch as on January 21st, 1909, there was a collision between two electrically operated trains near Marsh-lane Station on the Liverpool-Southport line. A train in the opposite direction, heavily laden with business people for Liverpool, was also involved in a fire which followed the collision, but all the passengers left the train quietly and only ten, who were in the trains from Liverpool, complained of shock or injury. As a result of that accident complaint was made to the Board of Trade as to the exits from the cars being at the ends only, and the late Colonel Druitt paid particular attention to that point at his inquiry. He said that the railway company claimed that the open car made a more strongly built vehicle and that side doors would cut into the framing of the sides and considerably weaken it, and in a bad collision greater risk would be run by passengers. It was also represented that side doors would produce delay in leaving stations. Tests made by the company showed also that sixteen passengers left by the two doors every ten seconds.

Notes and Memoranda.

ABOUT fifty American engineering colleges are carrying on organised engineering research. Fifteen of these received during the year 1924–25 more than $500,000 for research through co-operative relations with industry. The total annual expenditure by engineering colleges for research is more than $1,000,000.

IT is reported from New York that Mr. George Gordon Crawford, President of the Tennessee Coal and Iron Company, a subsidiary of the United States Steel Corporation, has been appointed chairman of a committee to establish the first technological laboratory in the steel industry. The purpose of the laboratory is to keep the steel industry in a vigorous condition, to find methods of making better steel, and to eliminate out-of-date methods as fast as possible.

IN the Kauri timber industry of New Zealand a large amount of waste wood is obtained, and the possibility of utilising it for papermaking is under consideration, states the annual report of the Imperial Institute. At the request of the New Zealand Forestry Department the Institute has examined samples of the waste wood in order to determine the yield and quality of the pulp which it will furnish. The wood contains varying amounts of resin, and a further investigation has been carried out to ascertain the nature and value of this resin, and whether it would be profitable to remove it before pulping.

AT the present time it may be said that the most commonly adopted arrangement for supplying a radio receiver is an accumulator for the low-tension supply, with an appropriate supply appliance or battery eliminator, for the high-tension supply. The low-tension accumulator may be maintained charged by means of some form of trickle charger, or by ordinary charging means. Probably, however, further developments in low-tension supply appliances will be made in due course, resulting in the manufacture of apparatus having the reliability and efficiency of some of the present forms of high-tension supply appliance.

A NEW type of welding electrode, which combines the characteristics of a fluxed electrode, and the quality of bead finish and the cleanness in handling of a bare welding electrode, has been introduced by the General Electric Company, Bridgeport, Conn., U.S.A. Recommended for the general welding of steel, the electrode has, it is claimed, a uniform flowing quality. The absence of spattering is one of the advantages claimed for the new material. The elimination of the erratic arc condition leads to a deposit of more material with the same consumption of electrode per kilowatt-hour. The electrode penetrates quickly and produces high tensile strength and unusual ductility and elongation.

A LIME whitewash for the brickwork of high temperature industrial furnaces can be prepared, according to E. P. Arthur, W. B. Kitchener and J. R. Withrow, in a recent paper to the American Chemical Society, by adding small amounts of silicate of soda to a lime-water slurry. The paint can possibly be improved by addition of common salt and plaster of paris, also in relatively small amounts. The use of lime paint on the brick work of furnaces not only improves appearances but also helps to reduce infiltration of cold air. If thoroughly mixed and applied in a thin coat to clean brickwork, a silicate-lime whitewash will not crack, flake, nor dust off under service conditions at temperatures as high as 350 deg. Fah. and slightly higher.

AN attempt is being made greatly to extend the construction of steam turbo-generators in Russia. At the works of the Electroforce (Elektrosil) in Leningrad the construction of 5000 kilowatt sets has been begun for the first time in Soviet Russia. At the same time preparations have been completed for the turning out of similar sets of 10,000 kilowatts, the patterns and drawings having already been finished. These machines are intended for the stations at Kieff, Novorossisk, Kizel, &c. The works, which belongs to the State Electrical Trust, claims to have orders on hand for 44 turbo-generators of a total of 240,000 kilowatts. In connection with the development of this branch large orders for milling and other machines were placed abroad.

AN interesting case of an electric motor breakdown was described by Mr. Hodge at a recent informal meeting of the Institution of Electrical Engineers. A 20 horse-power enclosed ventilated motor was set at work to drive several high-speed dry grindstones. After a few weeks the sparking at the brushes became so excessive that there was an occasional flashover. Tests were made for insulation, and overload, mica undercut, the brush position was verified, and apparently everything was in order. Still the trouble remained, until on one occasion whilst the shunt field was excited separately, it was noticed that the gap between the pole faces and the iron of the armature was bridged over by small particles of iron and steel, which in floating about in the air had been attracted by the magnetic field of the motor, although it was situated some 20ft. away from the nearest grindstone, and not in any direct line with the dust given off.

THE borough electrical engineer of Tynemouth, Mr. C. Turnbull, states in his annual report :—"The inauguration of the assisted wiring scheme has brought a very large number of new consumers in spite of the slump in trade. Many installations have been supplied which otherwise would not have come on to the system, and a great deal of work has been provided for men who otherwise would have been unemployed. In many cases current is supplied through prepayment meters, a method which is advantageous to both parties, there being no bad debts. So far the cost for the wiring has been met out of surplus funds, but as these have now been exhausted, the scheme has come to a standstill for the present. One may hope that means will be found to put it into operation again. A gratifying part of the assisted wiring scheme is the absence of faults or complaints from consumers, and the general high standard of the work done. One might have thought that this class of work might have been liable to scamping, but this is far from being the case. The workmanship and materials are of high class, and consumers may rest assured that they have obtained first-class installations at a very reasonable price."

Miscellanea.

So far as the home trade is concerned, the machine tool industry is slowly and steadily recovering from the shock of the coal dispute. Many firms report that trade during January and February of this year has been brisker, generally speaking, than last year, and that inquiries have been more numerous and of a sounder tone.

IN the course of a comparatively few years, the industrial electric heating load in the United States has grown from almost a negligible figure until at present it is in excess of 3,000,000,000 kilowatt-hours annually. This number of units, states the *Iron Age*, may be visualised more readily if it is considered that, to give this service, there would be required a power plant capable of carrying a load of 375,000 kilowatts continuously for twenty-four hours per day for 365 days.

REDRUTH Urban Council has adopted a scheme prepared by the surveyor, Mr. T. F. King, for augmenting the town's water supply by the acquisition of supplies from Filtrick and Penventon, at an estimated cost of £18,013, and has applied to the Ministry of Health for sanction to borrow this sum. The scheme includes the laying of a 12in. main from Filtrick to the present reservoir, a 6in. pipe from Penventon and the erection of a 50,000-gallon reservoir to be fed by means of a pump.

A BIG advertising campaign is to be embarked on in an endeavour to attract new industries to Tyneside. The matter was recently referred to by Mr. Richard Aughton, general manager of the River Commissioners, at South Shields. Pointing out that coal shipments had dropped 6,000,000 tons since before the war and that launches of new tonnage were down 50 per cent., he said it was absolutely essential that fresh business should be secured. The campaign is separate from the North-East Coast Exhibition, fixed for Newcastle in 1929.

THE first completed section of the new arterial road between Edinburgh and Glasgow was recently opened by Sir Henry Maybury, Director-General of Roads. The section is an important link at the eastern end of the new highway providing access for road transport direct to Leith. It has been named Maybury-road. The complete new Glasgow–Edinburgh road, which forms part of a national scheme to relieve unemployment, is estimated to cost nearly £2,000,000. The section opened has cost £48,000, and is about 1¼ mile long.

PALESTINE is intensely interested in the reported Colonial Office adjudication in favour of the two original tenderers for the most important Dead Sea concession, that for the extraction of potash, of which supplies are stated to be inexhaustible. It is anticipated that the starting up of this new industry, which potentially is the most promising asset in Palestine, will be of the greatest benefit to the country economically, from the point of view of labour conditions, Government revenue and the rectification of the present unfavourable balance of imports over exports.

DURING 1926 nine electric wall cranes of 3 tons, two floating cranes of 8 tons, and two 10-ton floating cranes, have been added to the equipment of the port of Antwerp, which on November 1st, 1926, consisted of 494 cranes of varying capacities, the most powerful being a 150-ton floating crane. There are also eighteen pneumatic grain elevators, capable of trans-shipping 200 tons of grain per hour. The tugboat service comprises twenty-eight tugboats, of which sixteen are fitted with powerful steam fire pumps. Eight of these tugs are specially framed for eventual use as ice breakers in the docks.

WITH the recent opening of a group of lines of the new telephone cable to Belgium, an improvement in the telephone service between this country and the Continent is expected. The cable was laid last year, and the new lines to Brussels are now in use. Other lines to Antwerp will be opened soon. The authorities state that the new cable should give greatly improved hearing and a quicker service. The new cable to France, which will not be opened for some little time, will eventually provide direct telephonic communication between Great Britain and Switzerland. At present, such communication can be obtained only over the French lines.

WHILST the German coal exports have decreased by about 200,000 tons since December last, the export of briquettes and lignite decreased 65 per cent. and 90 per cent. respectively. On the other hand, the German imports of English coal increased considerably since the conclusion of the English strike, amounting to 317,242 tons in February as against 136,190 tons in December last. The English coal trade has therefore regained its position on the German market. The German exports are decreasing in those countries in which imports from England are increasing, with the exception of Belgium and Italy, where long-term agreements were made during the British strike.

FOR the past twelve months the Bureau of Social Research for Tyneside area has been investigating the problem of unemployment. The Director, Mr. Henry A. Mess, in a report suggests a real danger of a considerable part of the population of Tyneside dependent on shipbuilding falling into a morass of more or less permanent under-employment, getting enough work to keep them hanging around the yards, but not enough to yield an adequate livelihood. Mr. Mess suggests the necessity for some kind of clearing house for labour. The clearing house, he says, ought to be controlled by a joint committee of employers and trade unionists working in conjunction with the Labour Exchange.

WORK has just commenced on the largest concrete highway bridge yet undertaken in the United States. This huge structure, 5 miles in length, will be built across Lake Pontchartrain and will link up New Orleans with the Mississippi Gulf Coast. It will embody two bascule bridges, one 150ft. span and the other 110ft. The viaduct will be an arched beam concrete structure, 30ft. wide between kerbs, having 35ft. spans supported on reinforced concrete piles. The roadway, designed for three lines of vehicular traffic, will be 15ft. above mean water level. There will be a handrail along each side of the bridge, but no footways for pedestrians. The project is being carried out by private enterprise at an estimated cost of £1,140,000.

HIGH-VOLTAGE OUTDOOR TRANSFORMERS

FERRANTI, LTD., HOLLINWOOD, ENGINEERS

(*For description see page 503*)

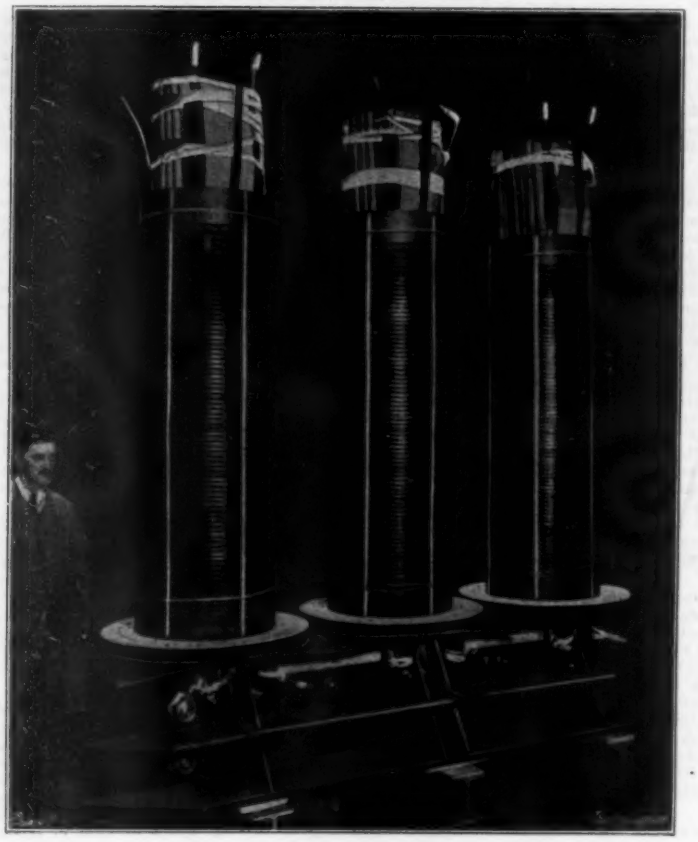

FIG. 1—LOW-TENSION WINDING

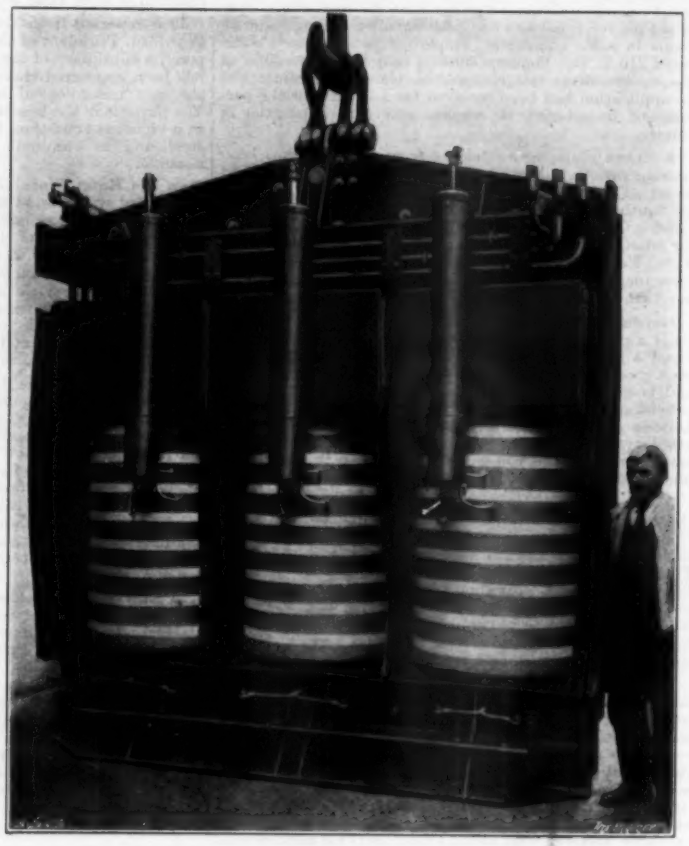

FIG. 2—TRANSFORMER REMOVED FROM CASE

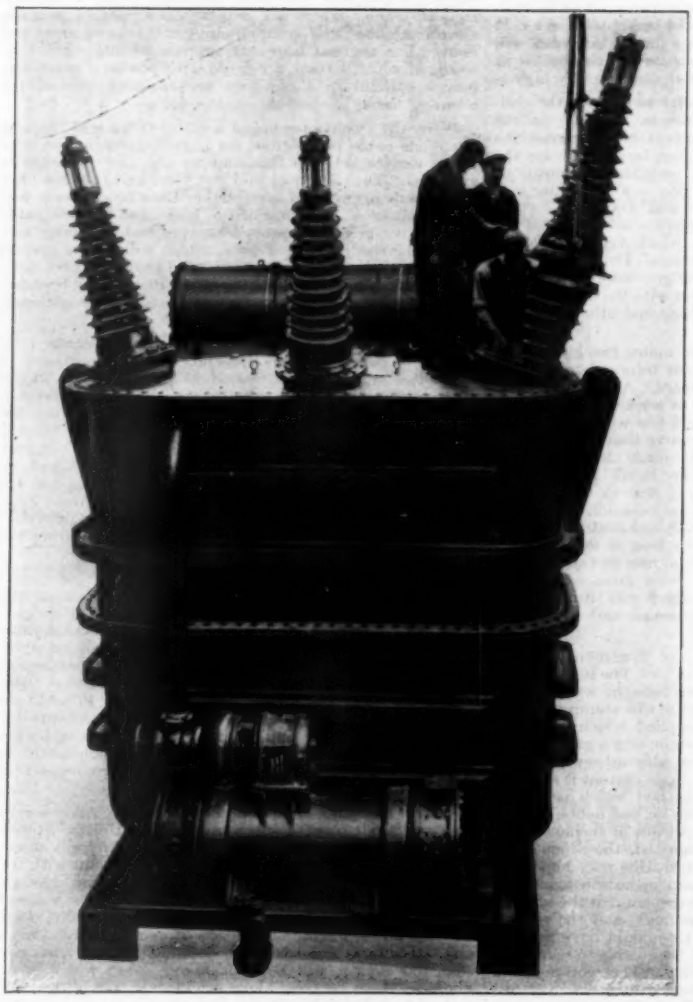

FIG. 3—ERECTING TERMINAL

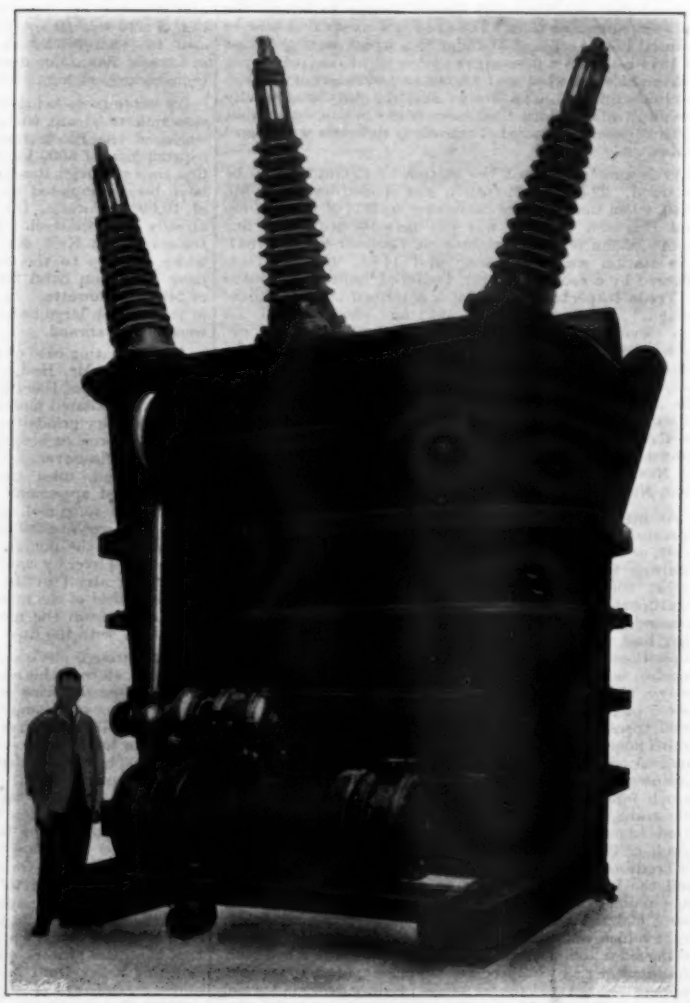

FIG. 4—COMPLETE TRANSFORMER

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THE ENGINEER.

MAY 6, 1927.

The Trans-Saharan Railway.

THE introduction of a Bill into the French Chamber of Deputies authorising the Government to provide 18 million francs to defray the cost of carrying out a technical survey and preparing the final plans for the construction of a railway across the Sahara Desert, indicates that this great scheme, which has been consistently advocated by the military authorities for nine years past, has at last entered upon a practical stage. In view of the supposed difficulties of constructing a railway across the desert alternative schemes have been proposed, such as the laying down of a line from Morocco through regions bordering the Atlantic Coast. This plan offered advantages from the point of view of construction and maintenance, and the line would pass through territory from which coal would be procurable. It did not, however, provide a direct route to the Niger, and the military authorities considered that the proximity of the line to the coast would leave it open to attack from the sea. All the alternative schemes have, in fact, been abandoned, and preference is now given to the original proposal for a direct line across the desert which survey parties declare to be quite practicable. The Sahara has been well prospected by motor cars and aeroplanes. Vehicles of the endless track and six-wheel types are now running over sandy wastes that were at one time regarded as impracticable except for caravans. The desert has lost its terrors, and engineers are looking forward to the time when a railway will run from Algeria across the desert to the south of Hoggar, where it will bifurcate, one line going south-west to Gao on the Niger and continuing to Bani, and the other south-east to Lake Chad and then down to the Congo, where it may be connected up with the future Belgian Congo railway system.

The practicability of constructing the Trans-Saharan Railway having been debated for so many years, it is significant that official impetus should suddenly be given to the scheme as offering the only solution of a problem of vital interest to the country's future. It is strategical, economical and political. France now extends from the North Sea to the Niger, but North Africa and the Niger Valley are isolated by the desert. The French regard the future with some concern, because the population of their country is practically stationary and because they are dependent upon other countries for their supplies of raw material. It is believed that these shortcomings will be made good by linking up the two great parts of the Empire by means of a railway. The population will be doubled by bringing 40,000,000 Africans into direct communication with France. The railway has therefore a strategical value by reason of its permitting the transport of a million native troops to France in case of emergency. It will complete the vast traffic organisation which includes the exceptional harbour extensions between Marseilles and Port de Bouc and the laying out of the Etang de Berre to provide the greatest inland ship accommodation in Europe. The Algerian harbours are being largely extended in order to deal with the future traffic to Marseilles. The French naval strategy is centred almost entirely upon protecting that traffic and making the route across the Mediterranean safe from attack. It is solely for that reason that France will accept no limitations on the construction of submarines or light surface craft unless she is assured that no attack can be feared. Everything is made subservient to keeping the Mediterranean route open. It is a link between the two parts of the French Empire which, it is urged, must not be broken. The railway is intended not only to ensure the transport of troops to France, but also to provide the country with practically all the raw material it may need. In a report accompanying the Bill authorising a credit for the survey of the Trans-Saharan Railway, extraordinary claims are made regarding the economic importance of the territories watered by the Niger and the Congo, as well as of the regions around Lake Chad. The Niger, with its periodical inundations, is declared to be fully as valuable for cotton cultivation as the Nile. Monsieur Mahieu, President of the Conseil Supérieur des Chemins de Fer, has made a complete study of the question, and affirms that the Trans-Saharan Railway will permit of the Sudan alone supplying all the products at present imported from Argentina and Australia at an annual cost of a milliard francs. In brief, the railway will ensure the fusion of the two parts of the French Empire, which will become self-supporting, since the territories in Central Africa will supply cotton, wool, timber, vegetable oils and even minerals and metals, while French manufacturers will find in Africa an important market for their goods.

This scheme of Empire development is an attractive one, although persons who have had experience of native labour are by no means convinced that the development will proceed so rapidly as is anticipated by those who look upon the Trans-Saharan Railway as a means of building up a vast Empire trade. Nevertheless, the exports from Senegal, the Sudan, French Congo and other parts of Africa are steadily increasing, and the efforts to interest natives in agriculture by means of experimental farms and the distribution of implements are certainly meeting with some measure of success. Everything depends upon European capital, European supervision and the employment of machinery which will make the best use of the sparse and inefficient labour. Central Africa will certainly, in time, prove of considerable commercial value to France if it is put into direct communication with the Mediterranean by means of the railway. Official efforts now aim at putting the scheme in hand with the least possible delay. It is pointed out that the enterprise is no more difficult than the construction of the railway from Cairo to the Cape. Obviously, the laying of a line across a desert where sand storms are of frequent occurrence, and where elaborate arrangements will have to be made for supplies of coal and water, must present problems of a character that are rarely met with in railway engineering. The cost is far too heavy to be borne by the State in the present condition of the national finances, but the report accompanying the Bill authorising the Government to provide credits for the survey of the line suggests that a large part of the cost may be covered by German reparations, while the various African colonies, which have generally surplus budgets, can be relied upon to help in the construction of a railway which is destined to consolidate the French Empire and to increase its power and prosperity.

The Manufacture and Behaviour of Springs.

AN interesting and, when analysed, a significant feature of the investigations described in the paper presented on Friday evening of last week before the Institution of Mechanical Engineers, by Professor Lea and Mr. Heywood, is to be found in the fact that whereas the research started as a somewhat academic study of the effect of repeated shear stress on materials subjected to various mean stresses, it ended as a very practical study of the strength and characteristics of helical springs. In reading the paper we feel that the authors' apparatus, as pretty an appliance of its kind as

we have ever seen, was too much for them. They fed it with specimens in the form of helical springs and it refused to give them results applicable to the material in other than helical spring form. That was an outcome that might, we think, almost have been anticipated. Research into the fundamental properties of materials demands specimens of a simple form which shall be under complete control, and the application to them of a simple controlled system of forces. Spiral springs fulfil neither requirement. Their form is relatively complex and after coiling cannot be controlled by the grinding or machining process applied to straight specimens, such as plain cylinders or rectangular bars. The stress system to which they are subjected when they are compressed or extended is not the simple pure shear that common practice takes it to be, but is, especially if the coils are openly spaced, a complex function of tensile, compressive, and shear stresses. The load causing failure may be readily determined, but the discovery of the stress corresponding to that load is a matter of high mathematics. These facts, we think, are quite sufficient to explain why Professor Lea and Mr. Heywood failed to reach the mark they aimed at. We do not, however, in any way regret their non-success. Their method is not the only possible one for investigating the fatigue of metals under repeated shear at various mean stresses. Others, Mr. Hankins' for example, are available, which are not open to the objections we have mentioned. Their investigation failed to attain its prime object, but it has given us a valuable new machine for testing helical springs, and has already shed, and promises to shed still more, light on the qualities and behaviour of these most important practical elements of construction.

Considering alike their ancient origin and the extent to which they are used in modern engineering and the arts generally, it is surprising to discover how little we really know concerning the theoretical and practical characteristics of springs. As a means of storing energy the spring is probably second in order of antiquity only to the raised weight. Its manufacture to-day is governed by tradition and the fruits of experience rather than by a fundamental knowledge of the form and characteristics required to meet specified conditions. That the production of springs should have attained the position it has reached to-day without material aid from theory or science entitles the spring makers to our congratulations. It implies that they have succeeded in a practical way in resolving problems connected with stress distribution and resistance to fatigue which theory is just beginning to understand. Many other branches of manufacture are conducted on a similar basis, a basis with which little fault can be found so long as it is not allowed to form an impediment to progress. Progress of a considerable amount is still undoubtedly possible in the manufacture of springs and with the increased speeds and heavier duties now imposed on spring-operated parts progress of a considerable amount is demanded. It is one of the outstanding merits of the investigation made by Professor Lea and Mr. Heywood that it has shown that springs as springs do not take full advantage of the fundamental properties of the material of which they are composed. It may be too much to say that the qualities of the material are, within limits, of secondary consideration, that in effect a spring made of mild steel may, in certain conditions, prove as satisfactory as one composed of the best spring steel. It is, however, no exaggeration to state that in the process of making a spring a condition is commonly induced in the material which lowers its life and strength below what they should be if they were determined solely by the primitive characteristics of the metal. In the case of helical springs the drawing of the wire, the coiling process and the final heat treatment of the finished article all assist in the degeneration of the properties which the spring ought to possess. These three stages in the manufacture, it appears from Professor Lea's investigation, adversely affect the surface condition of the material, and induce in the skin cracks and other defects which incipiently lead to failure or to a loss of the physical characteristics upon which the value of the spring depends. The safe range of shear stress which the spring can bear may, it seems, be reduced to 50 per cent. or less of that which the material in simple form without surface defects can withstand. In one instance Professor Lea found that material having an ultimate tensile strength of 120 tons per square inch could not, in the form of a helical spring, sustain without failure a varying shear stress the maximum value of which exceeded 34 tons or thereabouts. Had there been no surface defects the maximum value of the varying shear stress would presumably have been about 60 tons. The modulus of rigidity, the factor affecting the "rate" of the spring and therefore an item of much practical importance, would also appear to be adversely influenced by the surface condition. Its apparent value is in general not only reduced but is subject to a seemingly erratic variation in springs made from the same batch of material.

The results given in Professor Lea's paper relate entirely to helical springs. There can, however, be little doubt that in an equal or lesser degree they are also applicable to all other forms of spring, leaf, flat, volute, and so forth. They obviously imply that from the point of view of utilising the primitive properties of the material employed, springs as at present made display a considerable measure of inefficiency. For many purposes this inefficiency is not a matter of great importance. A constant degree of inefficiency in springs is of far more practical importance than a high efficiency. It would appear, however, from Professor Lea's investigation that constancy in the extent to which a spring reproduces the primitive characteristics of the material from which it is formed is dependent upon constancy in the surface defects. Uniformity in the processes of manufacture may secure much in this direction, but it seems doubtful wisdom to place complete trust in the realisation of such uniformity in, at any rate, the case of springs the failure of which might have vital consequences. A step in the right direction is the practice now being adopted in certain instances of grinding the wire for helical springs before it is subjected to the coiling process. That practice, however, removes only the surface defects caused by the wire drawing, and has no effect or very little effect on the formation of defects during the subsequent coiling and heat treatment processes. In all types of springs the removal of the surface defects by grinding or otherwise should be the last stage in the manufacture. Some forms of spring, leaf springs for example, present no technical difficulty in way of the execution of this work. Others, such as volute springs, are of a form which does not seem amenable to any kind of machine process. In these cases pickling or sand blasting would appear to provide the only possible means of removing the surface defects. The helical spring of circular wire, probably the most widely used of all forms of spring, is in an intermediate category. It can readily be ground externally and internally, but to deal completely with the whole of the circular surface of the wire calls for a machine which so far as we know is not at present in existence, but which, with Mr. Stromeyer, we believe to be not impracticable. As an alternative, to be considered in particularly important cases, it may be found desirable to replace helical springs of circular wire by helical springs of rectangular sectioned wire. Such springs have theoretically the disadvantage of possessing a stress distribution of a complexity requiring the mathematical ability of a St. Venant to resolve. In practice, however, they have the obvious advantage of permitting the removal of the surface defects by means of a grinding machine similar to or identical with that employed for grinding screw threads.

Literature.

Introduction to Reinforced Concrete Design. By HALE SUTHERLAND, M. Am. Soc. C.E., and WALTER W. CLIFFORD, M. Am. Soc. C.E. London: Chapman and Hall, Ltd. 1926. Price 20s.

SINCE many technical books have misleading titles, it is worth noting that Mr. Sutherland, who is Associate Professor of Structural Engineering, Massachusetts Institute of Technology, and Mr. Clifford, who is a consulting engineer, have produced a book which is entirely devoted to the subject of reinforced concrete design, no space whatsoever being taken up by descriptive matter or by details of subordinate importance. Their book of over 400 pages is therefore large enough to allow of a liberal interpretation of the word "introduction," the methods explained and the examples furnished being such as cover a large part of the whole subject, while, very properly, stopping short of the wider field in which design is considered in relation to the purposes of structures and to natural conditions, such as climate and surroundings. The authors have kept to the heart of the matter—that is, to the behaviour of the material under stress and the principles and methods to be followed in the design of elements and of a few important combinations of elements, such as retaining walls, complete columns, floors and some bridge spans.

Since the significance of the word "introduction" depends not only upon the authors' conception of the subject, but also upon the person who is introduced to the subject, it is necessary to point out that a study of the book suggests that those whose uses it may best serve are graduates in engineering, and those engineers who, being competent designers in other respects, have had little recent experience in reinforced concrete work, or wish to reconsider their methods. To the latter purpose the book seems to be especially suited. The authors intend their book primarily for the student of engineering, believing that it will also prove useful to the practitioner, and "it is assumed that the reader is conversant with the principles of applied mechanics and understands the elements of design in steel and wood. . . ." On a page which has the title "Hint to the Student," it is recommended that the book should be studied in connection with larger reference works, three American books being mentioned.

In dealing with the materials of concrete the authors, in accordance with their purpose, give only a few pages to materials separately considered, but carefully present the subject of proportioning, including mechanical analysis and the water-cement ratio theory, fourteen pages being devoted to the latter. The manufacture—making—of concrete, and a few pages on forms bring the reader to page 54, the rest of the book being devoted to design proper. The method followed is varied to suit the case, consisting usually of a description of the nature and distribution of stresses, an exposition of the methods of their computation and of the calculation of suitable dimensions. Typical examples are fully worked out and small problems, with solutions, are introduced—very helpfully in some cases. This feature of the book has not been overdone, there being in all only thirty-eight such problems.

Some portions of the work are noteworthy by reason of the methods followed or the fulness of treatment, such as the computations for cantilever retaining walls, the computations for interior column footing, Whitney's method of arch analysis (fifteen pages), a study of the general slope deflection equation, and the method of least work. Matter relating to notation, definitions, typical arrangements of reinforcement and the like accessory information are fully supplied, and the work is very well illustrated by diagrams and figures.

SIXTY YEARS AGO.

ALTHOUGH the Bessemer process had been established on a practical basis for several years, the use of steel plates and sections in the year 1867 for constructional and shipbuilding purposes was making very slow progress. Iron was still by far the favourite material with engineers. From a leading article published in our issue of May 3rd, 1867, it is to be gathered that many engineers and shipbuilders had had unfortunate experiences with steel and were definitely opposed to its employment. A certain amount of prejudice no doubt entered into the matter, but the principal cause of the feeling against steel appears to have been its untrustworthiness and the fact that it could not be obtained of a uniform quality in any large amount. The case of the screw steamer Istrian, built by Harland and Wolff, a vessel second in length only to the Great Eastern, had recently attracted considerable attention. Steel plates $\frac{5}{8}$in. thick were worked into the hull of this vessel, but two or three days after they had been fixed in position they cracked suddenly and had to be replaced by plates of Lowmoor iron. In another instance a small pleasure vessel of 100 tons register was built of steel angles and steel sheets $\frac{1}{4}$in. thick. When the hull was finished the plating presented an unusually irregular and unfair appearance, the position of every frame being marked on the outside by an undulation. The builder explained that he had found the steel most troublesome and difficult to work. It buckled in all directions, and as soon as it was applied close to one frame it flew off at the next. Tests conducted at Chatham showed that steel suffered very severely under the punch, and that to obtain satisfactory results all holes for rivets, &c., should be drilled. That steel could be made possessing remarkable properties was, we said, well known. A claret jug, we were aware, had been beaten up from a circular disc of Bessemer steel, and the same metal had been used for *repoussé* work, one of the most trying ordeals to which any metal could be subjected. These examples were, however, mere *tours de force*. A consistent supply in any magnitude of steel possessing great tensile strength and ductility could not be obtained. Many people went so far as to say that if steel gave satisfactory results it did so only because it had been reduced to the condition of iron by successive reheating and forging. What was wanted, we declared, was a material capable of bearing about 40 tons per square inch and at least as malleable and ductile as "best best" Staffordshire iron, the metal to be of a high degree of uniformity and to cost not more than 25 per cent. in excess of the best Staffordshire iron. We earnestly hoped that such a material would be made available to engineers and shipbuilders, but it is evident that we had grave doubts as to whether it ever would be. The subsequent improvements in the manufacture of steel, introduced by Siemens and others, took long strides towards the ideal we laid down, but it can scarcely be said that even yet we have quite realised it.

WORK has been begun on the construction of a railway from Guaqui, on the Lake of Titicaca (12,448ft. above sea level), Bolivia, to Puno (12,648ft.) on the other side of the water, in Peru. This will obviate the crossing of the lake by steamers as at present.

Obituary.

VISCOUNT COWDRAY.

THE world has become sensibly the poorer by the death of Viscount Cowdray, which took place early on Sunday morning at his Aberdeenshire seat, Dunecht House, to which he had journeyed on Friday last. His purpose in visiting Scotland, whither he was accompanied by Lady Cowdray, was so that he might be in Aberdeen on Tuesday last in order to receive, with his wife, the freedom of that city. During the seventeen years that he had owned an estate in the shire, both he and Lady Cowdray had rendered great services to Aberdeen and its neighbourhood, and it was in recognition of those services that the honour of the freedom of the city was to be conferred upon them. We understand that, had the ceremony taken place, it would have been the first time that husband and wife had been similarly honoured at the same time, and the first time that Aberdeen had conferred the distinction on a lady in her own right.

Lord Cowdray—or Weetman Dickinson Pearson, to call him by the name which he bore before being raised to the peerage, and by which he was, probably, best known by the majority of the community—was, of course, the head of the great contracting firm of S. Pearson and Son, Ltd. He was born at Shelley Woodhouse, near Huddersfield, in Yorkshire, on July 15th, 1856, and he was therefore drawing near to the completion of his seventy-first year at the time of his death. He was the eldest son of the late George Pearson, of Brickendonbury, in Hertfordshire, who was at one time a member of the Bradford Town Council—his mother being the daughter of Mr. Weetman Dickinson, of High Hoyland, Yorkshire—and grandson of Samuel Pearson, a native of Yorkshire, in which county he started in business as a contractor. Earlier in life, Samuel Pearson had, it is said, been in very poor circumstances, and had had to walk each day from Scholes to Leeds and back, to his work as a dry waller, for which he received the meagre remuneration of 2s. 6d. per day. The firm took on the name of S. Pearson and Son in 1856, when George Pearson was made a partner in it, and the title has remained unaltered until the present day.

Weetman Pearson was educated privately at Harrogate, and, in 1872, when he was but sixteen years of age, he was apprenticed to his father, the firm being then engaged on the extension of the Great Northern Railway from Bowling to Bradford Exchange station. Having regard to the fact that both his father and grandfather were Yorkshire men, and were therefore unlikely to do anything rashly or without ample reason, it is significant that three years later, when the lad was only nineteen, he was taken into the business as a partner. Subsequent events showed how amply justified the step had been. Prior to that time, the business of the firm, though we believe that it had been perfectly successful in a more or less small way, had been confined to Yorkshire and the North of England, the headquarters being at Bradford. The young recruit, who soon proved himself capable of taking charge of important work, and who had wider views than either his father or his grandfather, determined to enlarge the sphere of its operations. He undertook journeys abroad, and in that and other ways he laid the foundations for the enormous undertaking of which subsequently he became the head and guiding spirit. To write his whole life history would be to give a complete list of the many important works which his firm carried out during the half century and more that he was connected with it, for with each and every one of them he identified himself completely. To give such a list in a memoir of this kind would, however, be impossible; it must suffice to refer to a few of them.

Just after he became a partner it fell to his lot to carry out some sewerage works at Southport. The operations presented considerable difficulties which the young contractor surmounted with such skill that work poured in on the firm, and the importance of the business so increased that in 1884 it was found necessary to transfer its headquarters from Bradford to London.

The work which, perhaps more than all others, served to bring Weetman Pearson's name before the general public was the construction of the Blackwall Tunnel, which was opened for service in 1897. The idea to construct this tunnel was originated, prior to 1886, by the old Metropolitan Board of Works, of which the late Sir Joseph Bazalgette was the Chief Engineer. In the session 1886–87 the Board obtained an Act sanctioning the construction of two tunnels for vehicles and one for foot passengers. It was decided to proceed at first with the construction of the foot passenger tunnel, and the drawings for a tunnel having an internal diameter of 15ft. were prepared by Sir Joseph and tenders asked for late in 1888. Apparently only two firms tendered for the work, and the offer of Messrs. Pearsons, the amount of which was just under £320,000, was the lower and was accepted. The work was, however, not destined to be carried out at that time, for, simultaneously, the London County Council came into being and took the place of the Board of Works, with the consequence that the contract for the tunnel was never sealed. The matter was not, however, dropped; it was only postponed, and during the following couple of years or so the late Sir, or as he then was Mr., Alexander R. Binnie, the Council's Chief Engineer, after consulting with the late Sir (then Mr.) John Wolfe Barry and Sir Benjamin Baker, reported to the Council that an internal diameter of 15ft. was too small, and suggested that the dimension should be 24ft. 3in. and the external diameter 27ft. Again, drawings were prepared, and again tenders were invited. On the second occasion six tenders were received, and, again, that of Messrs. Pearsons—just over £870,000—was the lowest and was accepted, and the work of construction began in 1892 It is worthy to be put on record that the engineer in charge for the contractors was Mr., now Sir E. W. Moir, Bart., M. Inst. C.E., now a director of the firm, and that the resident engineers, acting on behalf of the County Council, were Mr. David Hay, M. Inst. C.E., and the late Mr. (afterwards Sir) Maurice Fitzmaurice.

There were many who were ready to prophesy that this tunnel could never be satisfactorily driven, and considerable pressure was put upon Mr. Pearson to relinquish the work. It was characteristic of the man, however, that when he had once made up his mind that a certain work could be carried out, he went through with it until it was finished, and finished well. It should be explained, however, that he never entered into any contract without having satisfied himself, in every particular—even down to the apparently non-important items—that the proposed operations were feasible. He was well qualified to form accurate opinions in such matters, as he had taken care to qualify himself to carry out, personally if need be, any and every kind of work that might present itself. In the case of the Blackwall Tunnel, the prophets were wrong; the tunnel was satisfactorily completed, though a good many very serious obstacles, some of them foreseen and some unforeseen, had to be overcome. One of the troubles was that part of the cutting edge of the shield encountered some hard substance when about 125ft. of the tunnel had been excavated. Since it was impossible to withdraw the shield to the vertical shaft from which it started or to repair the damage until a further shaft was reached, it was necessary to drive the injured shield forward several hundred feet to the next shaft, special arrangements having to be made in order to relieve the damaged part as much as possible from pressure. Then, again, there was at one point a depth of only 5ft. 2in. of sand and gravel over the top of the tunnel, and there was great difficulty in keeping water out of the workings. The expedient—proposed, we believe, by Mr. Pearson—of dumping on the bed of the river a layer of clay 10ft. deep and extending for some 75ft. on each side of the centre line of the tunnel, helped matters considerably, since, when there was a tendency for the water to break through, the clay went down with the sand and helped to prevent its ingress. The total length of the tunnel, including approaches, is 6200ft., 1735ft. of that distance being open approaches.

Before the work was completed, Mr. Pearson had succeeded his father as head of the business, and, a couple of years or more before the tunnel was opened, he was, for the fine work he had already done in connection with it, created a baronet. That was in 1894. A further result of his achievement, and a result which, in its way, was as great an honour as that of being made a baronet, was that his firm was invited—it did not seek for the work—to construct four railway tunnels under the East River from New York to Long Island. For any but a United States firm to be asked to carry out engineering work in the neighbourhood of New York City caused world-wide surprise, but the manner in which the operations were carried out gave ample proof of the wisdom of the choice. There were, of course, difficulties to be surmounted, and they were difficulties which were different from any that the firm had up till then encountered; but it was said at the time that a trouble had only to be encountered for Sir Weetman to find a way—and a successful way—out of it. The tunnels, which have a total length of 9600ft., start at First-avenue in New York City and terminate at Thompson-avenue in Long Island. There are four parallel single-track tunnels, which are in two pairs, the tunnels of each pair being 37ft. apart. The work of excavation was carried out by means of two shafts on each side of the river, two being in First-avenue, N.Y., and two in Front-street, Long Island. The two former are 225ft. apart and the two latter 103ft. apart, and they varied in depth from 74ft. to 88ft., and were 40ft. in diameter. The tunnels were driven by shields having a diameter of 23ft. 6¼in.

It was during the period between losing the first Blackwall Tunnel contract and securing the second that Mr. Pearson began a connection which was to have a very considerable bearing on his later career. He visited Mexico in the year 1889. What originally drew him to that country we do not know, but that he had from the first some definite object in view would, having regard to his well-known character, appear to be certain. Of Mexico at that time very little was generally known in this country, and of that little, not all was good. Evidently however, Mr. Pearson had noted its vast possibilities and determined to take advantage of them. Even he, however, could hardly have foreseen in full the wonderful results which were to accrue from that visit. Getting into touch with President Diaz, he almost immediately got orders to carry out a drainage scheme, and then to construct an extensive system of railways, and they were followed by a comprehensive programme of harbour and waterworks building. Between the two men—Diaz and Pearson—there appears to have sprung up a warm friendship, in which mutual trust played a prominent part, and between them—for it would have been impossible for the contractor to do what he did without the support of the ruler—they entirely altered conditions in the country, creating order out of chaos.

It was his connection with Mexico that brought Sir Weetman into touch with oil, and possibly brought him a greater fortune than he had amassed during the whole of his career as a contractor. With two powerful oil companies already operating in the country, it was considered by many to be a hazardous undertaking for a third to enter the field, yet he did not hesitate to do so, and by the exercise of infinite patience and a display of doggedness and inflexible will, comparable with that evinced by our great

VISCOUNT COWDRAY

admirals on the Spanish Main three hundred years before, he won his way. He obtained concessions, bored for and obtained vast quantities of oil—losing a lot by gushers as well, be it said—and succeeded in founding one of the leading oil organisations of the world. In doing what he did, he must have sunk millions of pounds sterling, for the method he employed was that of persistently underselling his competitors. Yet, there is little doubt that in the end he much more than made up for his losses. He is credited with having been the first to employ oil tankers and to fill them direct by oil in bulk led by pipe lines from the oilfields. He did not retain his connection with the Mexican oilfields till the end of his life, however, for some years ago the rights of the Mexican Eagle Oil Company, Ltd., which had been formed to acquire Messrs. Pearsons' concessions, &c., were made over to the Shell group. He did, however, subsequently investigate the possibilities of obtaining oil by means of bore-holes sunk in Derbyshire.

We have so far mentioned only a few of the undertakings in which Sir Weetman, as head of his firm, was intimately concerned. Another most important business was the enlargement of the Admiralty Harbour at Dover, a costly and hazardous enterprise, having regard to the difficulties of the Channel in the locality, that was brought to a most satisfactory conclusion. Other docks constructed by the firm were at Hull, London and Southampton in this country, and at Malta, where also an extensive breakwater had to be constructed. Of the railways built, there were—to name but a few—the new direct line to South Wales for the Great Western Company, the large-diameter tunnel line for the Great Northern and City Railway between Finsbury Park and Moorgate-street, and, of course, the network of lines in Mexico, of which mention has already been made.

Another project which greatly enhanced the reputation of the firm, and in which Viscount Cowdray, as he had then become, took a keen interest, was the completion of the Sennar Dam on the Blue Nile. That huge structure was begun in April, 1921, by Messrs. Alessandrini and Perry, and taken over and continued by Messrs. Pearsons in December, 1922. The completion was effected in an astonishingly short period, the operations during each period of low Nile being carried out rigidly to schedule. It was a magnificent piece of work, magnificently designed and carried out, and—apart altogether from the praise due to those who initiated and designed it—it may well be said that, even if the firm had done nothing else in the course of its career, it would have, by the construction of the Sennar Dam alone, amply established its reputation.

The list of great works successfully carried out might be enlarged almost indefinitely, but enough has been said to show the diversity of projects with which the names of Pearsons and Viscount Cowdray are so honourably coupled. We might, however, mention in conclusion that among the schemes on which the firm is at present engaged are the extension of the Valparaiso breakwater and the construction of the dam in the Silent Valley for the Belfast waterworks. It also carried out work some little time ago in connection with the development of the Kent coalfield.

In spite of the many other calls on his time, Lord Cowdray, before being elevated to the peerage, sat for fifteen years—from 1895 to 1910—in Parliament as Liberal Member for Colchester. He was made Baron in 1910, taking the title of Lord Cowdray of Midhurst, and Viscount in 1916. During the war he was, at first, largely responsible for the design and construction of the gigantic explosives factory at Gretna Green, and he, too, built a tank assembly factory in France. Then, from early in 1917, he was for nearly a year President of the Air Board, and during that short period he effected outstanding improvements. It was never publicly made clear why he relinquished that position, but though he severed direct connection with the Air Force, he continued to the end of his days to take the keenest interest in it and in the welfare of its men.

Among the many appointments which he held from time to time were the Rectorship of Aberdeen University from 1918 to 1921; and the Deputy Lieutenantship of Aberdeenshire. He was also High Steward and a Freeman of Colchester and Lieut.-Colonel in the Royal Engineers (T.A.). He was made G.C.V.O. a couple of years ago, and was also a Privy Councillor. During his lifetime, Lord Cowdray made many generous gifts, the full extent of his benefactions will, possibly, never be known, but several hundreds of thousands were devoted to the Royal Air Force Club, and large sums to the League of Nations Union and the Imperial Institute.

THE reorganisation of the railways of Northern and Southern Rhodesia has necessitated the appointment of a chairman of the Rhodesian Railway Commission. Mr. E. H. Hiley, who, on behalf of the Beit Railway Trustees, investigated the railways of Rhodesia, has been appointed to that position, but he will only hold it for one year and then be succeeded by Sir William Hoy, the general manager of the South African Government Railways. Mr. Hiley is an old North-Eastern Railway officer, was for some years the general manager of the New Zealand Government Railways, and was a member of the Acworth Committee that inquired into the administration of the railways of India.

Extensions to the Treforest Power Station.

APART from restrictions governing the supply of electricity to certain urban districts and county boroughs, the county of Glamorgan and that part of the county of Monmouth that lies west of the river Usk form the area of supply of the South Wales Electrical Distribution Company, which is entitled to provide electricity for any purpose within the area to authorised distributors who are empowered by special Acts or by Provisional Orders to supply electricity for power to anyone who may need it. The principal power station, put into operation on April 30th, 1904, is on the river Taff, near Treforest, where fourteen Niclausse boilers and three Willans engine sets, each having a capacity of 1500 kilowatts, were originally installed. A smaller station was also built at Cwmbran, near Pontypool, in Monmouthshire, but it was shut down in 1909, after the Monmouthshire area had been connected to Treforest, and two other power stations, one at Bridgend and the other at Neath, were handed over in 1908 under agreements confirmed by a special Act to the Bridgend Urban District Council and the Neath Rural District Council respectively. The shutting down of the Cwmbran station and the centralisation of generation at the Treforest station resulted in appreciable working economies, and the growth of the output since the date of that arrangement has been very pronounced.

The number of supplies given by the company to collieries and other industrial undertakings is about eighty, and the number of supplies to authorised distributors holding lighting orders, including those held by the company, is twenty-two, representing an aggrgeate horse-power connected of 94,000. The reciprocating engines at the Treforest station were run until 1908, when a British Westinghouse 3000-kilowatt turbo-alternator was installed, this being followed in 1911 by a Willans-Dick-Kerr set of the same output, and in 1914 by a 5000-kilowatt set made by the same firm. The steady growth in the demand led in 1920 to the placing of an order with

FIG. 1—GENERAL VIEW OF THE TREFOREST POWER STATION

C. A. Parsons and Co. for a 18,750-kilowatt set designed for a pressure of 350 lb. per square inch, the working pressure previously being 200 lb. per square inch. Even before this set was put into operation, however, it was evident that additional plant would be needed, and in 1923 Mr. J. S. Highfield was appointed consulting engineer to advise and carry out future extensions.

The total mileage of the feeder and distribution system belonging to the company and to undertakings that derive their supply from the company is 211, of which 102 miles are overhead and 109 miles underground. The Act of 1900 empowered the company to obtain electric lighting Provisional Orders authorising it to supply electricity for lighting in any part of its area not already covered by Provisional Orders obtained by others. At present the Provisional Orders which the company holds are as follows:—Abercarn, 1914; Caerphilly, 1904; Cowbridge and Penybont, 1914; Llanfrechfa, 1927; Llantrisant, 1926; Llantwit Fardre, 1912; Panteg, 1921; and St. Mellons, 1922. The company also supplies electricity in bulk to the following Urban

FIG. 2—INTERIOR OF ENGINE HOUSE

District Councils:—Bedwellty, Bedwas and Machen, Caerphilly, Cardiff, Gelligaer, Mountain Ash, Mynyddislwyn, Ogmore and Garw, Pontypridd, Rhondda, and Risca. It also gives a partial supply to the Cardiff Corporation and supplies to the Mardy Electric Lighting Company, the Merthyr Electric Lighting and Traction Company, and the Pontypool Electric Light and Power Company.

The general system of transmission is by means of feeders which are also used for giving supplies direct to consumers, as well as by a distribution network, the three-phase extra-high supply and transmission being at a pressure of 11,000 volts. In order to meet development it was decided to consider the system of feeders and mains as they existed in 1923, *i.e.*, practically as a distributing system, and to design and gradually carry out a new system of feeders to connect with this distributing network, so as to supply it at

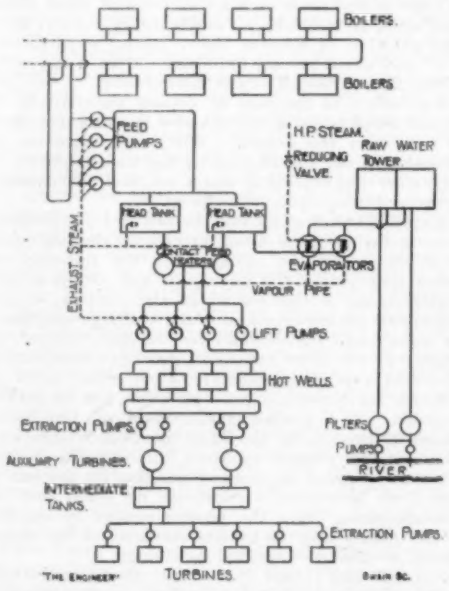


FIG. 4—BOILER-FEED HEAT RECOVERY SYSTEM

appropriate points. A radial system of feeders was therefore designed with step-up transformers at the power station for raising the pressure to 33,000 volts, and with transformer sub-stations for reducing the pressure again to 11,000 volts where connections are made to the distribution system. Two 33,000-volt feeders have been run from Treforest, one to the Glen Valley in Monmouthshire and the other to Barry, but at present both these feeders are working at 11,000 volts. The Glen Valley feeder is 13 miles long and consists of a six-wire overhead line. Each conductor has a section of 0·1 square inch, and is carried on pin insulators on a cross arm, together with an earth wire of the same size. The cross arms are fixed to steel lattice towers, normally spaced 400ft. apart, the longest span in hilly country being 902ft. The Barry feeder is 12 miles long, and the end which passes through Barry to the docks is in the form of a cable. The electricity for the docks is supplied by the company to the Great Western Railway Company.

While the 18,750-kilowatt Parsons set was being installed in the old power station to meet the immediate needs, the company arrived at definite conclusions concerning all future extensions.

The policy with regard to a steam pressure of 350 and a temperature of 750 deg. had already been settled, for those were the steam conditions laid down for the 18,750-kilowatt set and all subsequent sets. In addition, however, the company decided, whilst this large set was being constructed, to enlarge the buildings so as to enable them to accommodate eight boilers, each capable of evaporating 60,000 lb. of water per hour, and two additional 18,000-kilowatt generating sets, with all the necessary auxiliary plant. To enable the new plant to take over the work of the old plant, which will gradually be put out of service, the extension has been made self-contained, and when the whole of this reconstruction work has been completed, the station will contain six sets with capacities ranging from 16,000 to 20,000 kilowatts, with the corresponding boiler and auxiliary plant. Exterior and interior views of the station are given in Figs. 1 and 2, whilst Fig. 3 shows a plan and section of the station, the cross-section of the new part of the turbine room being the same as that of the old. The foundation blocks for the turbines are built up from what was the original floor level, and a light continuous platform has been constructed around the turbines, but there is no continuous floor level from wall to wall, as in the old part of the building. Consequently, the open basement floor is provided with plenty of light, and it is accessible to the overhead crane. Besides the 18,750-kilowatt set in the old part of the building there is now a 16,000-kilowatt unit in the new section and two 1000-kilowatt sets which supply current for the condensing water pumps, extraction pumps, boiler fans and other auxiliary plant, and their exhaust steam plays an important part in the feed-water heating system,

Of the eight boilers in the new boiler-house, the first four are equipped with superheaters and air heaters, whilst the second four are also equipped with small economisers. A complete equipment of feed pumps, service pumps, tanks, condensing water pumps, cooling plant and ash-handling plant makes the boiler-house extension complete in itself, and entirely independent of the old equipment. In the event of the coal-handling plant failing, a full-gauge railway truck can enter the boiler-house by a ramp, so that the coal can be delivered direct on to the stoking floor, whilst a similar track, but of narrow gauge, forms a stand-by for the ash-handling plant. An overhead tank, supplied from the river through filters by an independent pump provides the make-up water through evaporators for the boiler feed and for general service purposes. A storage battery provides current for the remote control solenoids of the main switch-

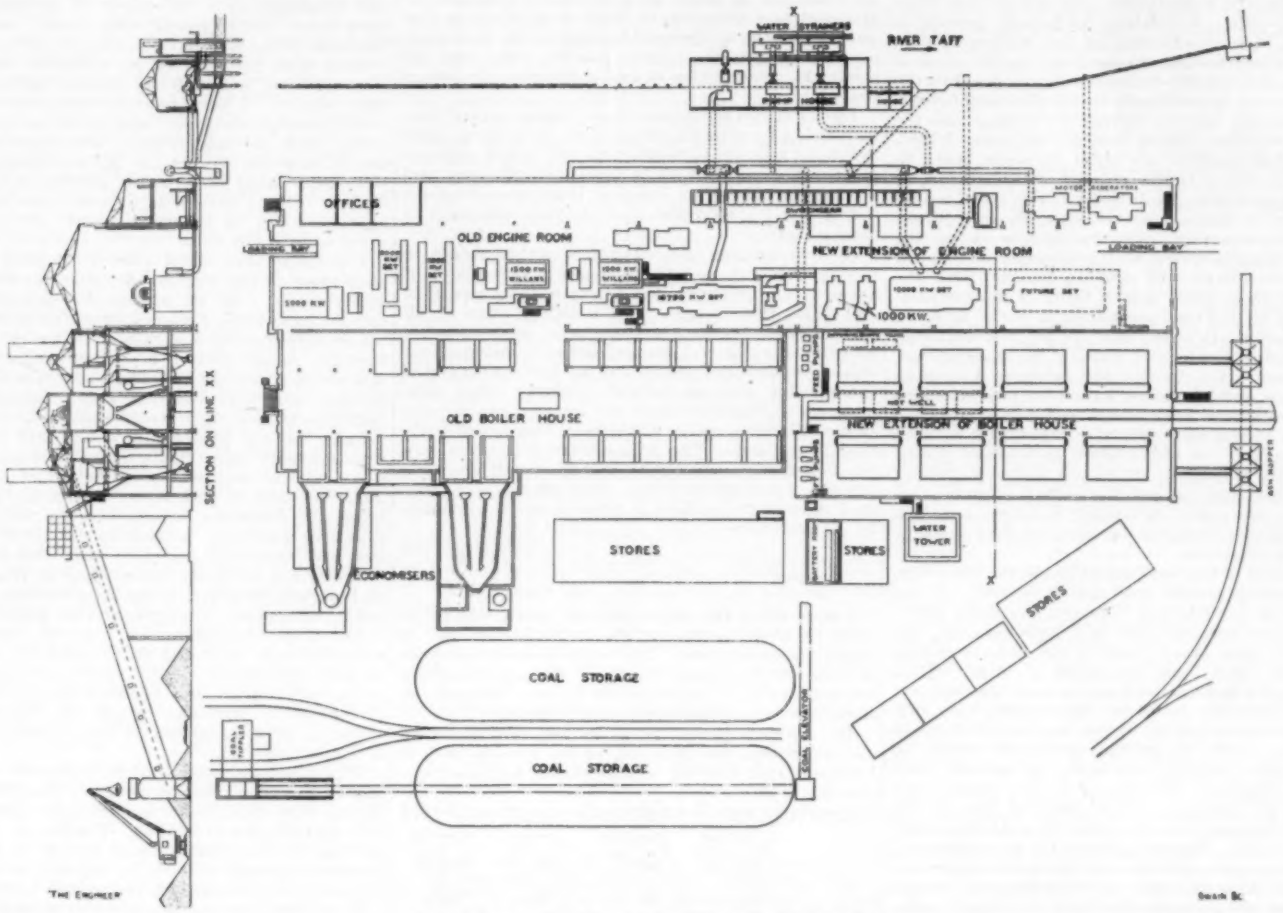


FIG. 3—PLAN AND SECTION OF THE POWER STATION

gear, and has sufficient capacity for emergency lighting in the power station. The diagram, Fig. 4, gives the arrangement of the boiler feed and heat-recovery system, which possesses interesting features. The whole of the condensate from the main turbines is collected in intermediate tanks, and is used in

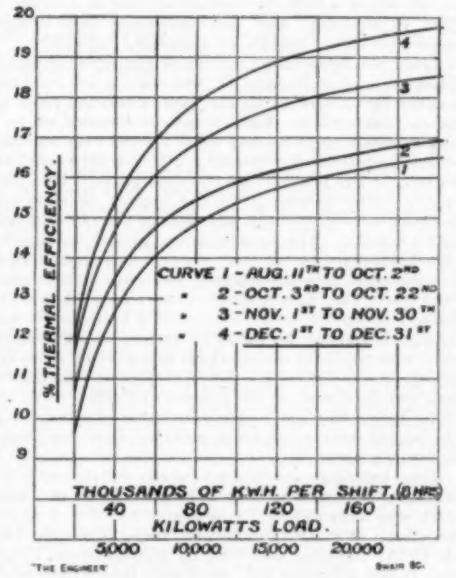


FIG. 5—THERMAL EFFICIENCY CURVES

jet condensers, forming part of the two 1000-kilowatt auxiliary turbine equipments. The main turbine condensate condenses the auxiliary turbine steam, and in doing so has its temperature raised to about 150 deg. Fah. This hot water is delivered by extraction pumps to hotwell tanks in the boiler-house basement, and from the hotwell tanks steam-lift pumps deliver the main turbine condensate to head tanks, and on its way the water condenses the exhaust steam from the feed pumps, as well as the vapour from

the evaporators which supply the make up feed water. These processes raise the temperature of the main turbine condensate and make up water together to about 200 deg. Fah., and from the head tanks the water falls to the boiler feed pumps.

At a later date a de-aerating plant is to be added, and it will play its part in the station heat-recovery system. At present the steam from which heat is recovered for raising the temperature of the feed water is the exhaust steam from the 1000-kilowatt auxiliary turbines, the steam feed pumps and the steam from the evaporators. As can be seen from the curves—Fig. 5—relating to various periods in 1926, the thermal efficiency of the station is high, owing in a large measure to the design and economical operation of the boiler-house. As far as possible, the boilers are run continuously under the most favourable conditions, and, to prevent air leakage into the furnaces, the ash hopper outlets are water sealed. Soot or dust blowers are fitted to every boiler to enable the tubes to be cleaned externally under running conditions. Each boiler is also fitted with a coal meter, a steam flow indicator, draught gauges and a CO_2 indicator. The furnaces work on the balanced draught system with pre-heated air supplied to both the forced and induced draught fans, the automatic chain grate stokers being of the compartment type, so that the forced draught can be adjusted over the full length of the fire. To prevent scattering dust and dirt inside and outside the boiler-house, each chimney is fitted with a dust catcher. A separate record room and laboratory have been provided with all the necessary instruments for integrating and recording during each shift the steam used by each boiler, the flue gas temperature at selected points, the quantity of make up water and the total quantity of feed water pumped into the boilers. For the new generating units new switchgear has been installed, each of the main switches having a breaking capacity of 500,000 kilowatts.

On account of the flood conditions of the river Taff, the condensing system is of special interest. As the course of the river is in a restricted and steep watershed, its level rises and falls with great rapidity, and sometimes after heavy rainfall the flow is choked with leaves and large quantities of other *débris;* but, notwithstanding, the water may in the course of a period of twelve hours run quite clear, with only sharp sand or slurry in suspension, and this gritty suspended matter cleans the condenser tubes. In normal times, however, the water occasionally may deposit a gummy substance on the tubes, and in order to maintain the vacuum it has in the past been necessary to clean the tubes as frequently as once a week. The pump-house for the condensing water has been built on the river bank, and to prevent leaves and other floating matter entering the pumps, the suction inlets are provided with revolving screens, which are continually cleaned by water jets. Two sets of nozzle pumps are used for normal and for flood conditions, those for the latter having three times the power of the former. There is also a chlorinating plant for treating the turbid water, and it entirely removes the gummy matter and prevents its accumulation. When, however, sharp sand in suspension is coming down the river, the chlorine is unnecessary. The result of employing these different methods of treating the water is that the vacuum attains an average of 29in. of mercury, and the condensers only require inspection once a month, or even less frequently.

From the Maes Mawr sidings of the Great Western Railway coal is brought to the station by rail, the wagons being hauled to the power station yard by steam locomotives. Each wagon is shunted on to a tippler which grips it, and when turned over the coal is discharged into a concrete pit. A spout at the bottom of the pit delivers the coal on to a belt conveyor, which carries it to the hopper of a second inclined conveyor at the junction of the old and new boiler-houses. The coal is then carried on this inclined conveyor to the roof, where it is delivered on to a horizontal belt discharging into the boiler-house bunkers. The first conveyor is raised above the ground to enable coal to be stored beneath it, and storage heaps can be made by means of a travelling jib crane, which is also used for transferring from the storage to the conveyor. By these means some 12,000 tons can be stored on the ground and 600 tons in the boiler-house bunkers. The conveyors can deliver at the rate of 100 tons an hour, and the crane can handle 30 tons an hour.

The building extensions were constructed by Watkin, Williams and Sons, of Llanishen, the steel work was supplied by Braithwaite and Co., Ltd., of Newport; the 18,750-kilowatt turbo-alternator set by C. A. Parsons and Co., of Newcastle-on-Tyne; the 16,000-kilowatt set, with the Hick-Hargreaves condenser, by the English Electric Company, Ltd.; the high-pressure boilers by Babcock and Wilcox; and the ash plant by the Underfeed Stoker Company. The 1000-kilowatt auxiliary turbo-alternators were constructed by W. H. Allen, Sons and Co., Ltd.; the switchgear by Reyrolle and Co., Ltd., of Hebburn-on-Tyne; and the coal-handling plant by Fraser and Chalmers, of Erith.

IT is announced that the Portuguese Government will shortly make known plans by which, it claims, Portugal will within a few years be provided with roads suitable for all kinds of traffic.

Iron and Steel Institute.

PRESIDENTIAL ADDRESS BY F. W. HARBORD.*

So far as we can see at present, there is no indication of any new process, either in iron or steel manufacture, which is likely to revolutionise our present methods of production, and such improvements as may be possible must be effected by the necessary modifications in plant at a minimum cost and by giving greater attention to detail in working, so that our plants may be operated to produce the maximum output and give the highest possible yield with the minimum consumption of fuel and labour per ton of output.

I will ask you to consider, first, capital expenditure in relation to manufacturing costs, and, then, some questions relating to works practice, which seem to me to offer possibilities of increased efficiency and economy; but before bringing these considerations before you I should like to draw your attention to certain facts.

Notwithstanding the enormous developments in modern industry and the immense increase in production of all commodities between the years 1890 and 1912, the average world's selling price of all commodities taken together rose approximately 25 per cent. In this generalisation is included not only manufactured goods, but all foodstuffs, and if these latter and all natural products other than minerals had been omitted, the average rise in price of manufactured goods would have been much more than 25 per cent. The price of some rose more than the 25 per cent.; some less; and a few, but very few, actually decreased in price. Amongst some of those that showed an increase in price above the average 25 per cent. were:—

	Per cent. (approx.).
Pig iron	30
Copper	52
Tin	132

I have taken the above pre-war period, ending at 1912 to avoid including abnormal fluctuations in prices due to the war. The large increase in copper and tin was principally due to the demand exceeding the supply—a condition which has not affected the steel industry to any appreciable extent.

The average quoted prices for pig iron and steel rails in Europe and America for the periods 1891 to 1895 and 1908 to 1912 were as shown in the accompanying table:—

	Average five years, 1891–95.	Average five years, 1908–12.	Average five years, 1891–95.	Average five years, 1908–12.
	Pig iron.	Pig iron.	Rails.	Rails.
British	£2 6s. 6d. (Hematite)	£3 4s. 4½d. (Hematite)	£4 1s. 6½d.	£5 13s. 8d.
Cleveland	£1 17s. 1d.	£2 11s.3½d.		
American	£2 16s. 1d. (Bessemer pig acid)	£3 9s. 6d. (Bessemer pig acid)	£5 13s. 8d.	£5 16s. 8d.
German	£2 12s. 6d.[1]	£2 19s. 1d. (Hematite)	£5 13s. 9½d.	£6 1s. 9d.
Belgian	—	—	£4 2s. 8d.	£5 8s. 0d.

[1] For the four years 1891, 1892, 1893, and 1895; figures for the year 1894 were not available.

It will be noted that the average prices of American and German rails for the five years 1891–95 were practically the same as the average price of the British rails for the five years 1908–12. This was largely due to the fact that the iron and steel industry was only beginning to develop on modern lines in both these countries in the late 'eighties and early 'nineties. Both of these countries, by the erection of modern plants, with improvements based largely on our experience, and by the development of their iron ore and coal resources, were able to reduce their working costs sufficiently to enable them to produce rails in 1908–12 at little above the average price for 1891–95, notwithstanding the general increase in the price of raw materials. The development of the steel industry in America was assisted partly by protective duties and largely by the special conditions of her home market. The invention of the basic process made available for the German manufacturers all the phosphoric ores in the Alsace-Lorraine district, and rendered possible a great German iron and steel industry.

The selling price depends upon the cost of production, which in the case of pig iron includes the following items:—Raw materials, including ore, limestone and coke, refractories; labour, including productive and repair labour; technical and general supervision and management; office and selling charges; repairs; depreciation of plant; general overhead charges, such as rent, rates, taxes, insurance, social charges, &c. The selling price is the sum of the above, plus such profit as the consumer will pay. All these charges during the period under consideration have followed the general trend and increased with the price of commodities, which explains the increase in the price of pig iron and steel.

I wish particularly to direct your attention to the heavy increase in capital expenditure between 1890 and 1912, which was necessitated by the demand for large quantities of iron and steel, and the extent to which the charges, both for repairs and depreciation, have increased the cost of production.

The cost of repairs, we know, increases as the expenditure on the plant increases, but not in any definite ratio, and will vary within such wide limits, depending upon the particular plant, that I have made no attempt to estimate it separately, but have included it with depreciation charges.

The capital cost of a completely balanced iron and steel plant in 1890, which can be fairly compared with a plant built about 1910–12, is extremely difficult to obtain with any degree of accuracy. Complete open-hearth plants with coke ovens, blast-furnaces, mills, &c., did not exist in 1890, or, at all events, were not erected as complete plants, but were built up gradually by making additions from time to time. I have, however, been able to obtain from a number of different sources the cost of separate units, such as coke ovens, blast-furnaces, open-hearth furnaces, &c., at the different dates, and by comparing these built under different conditions I have, I believe, been able to arrive at a very close approximation to the relative cost of a complete plant in 1890 and 1912.

I estimate that about 1890 a complete iron and steel plant in this country designed for rolling rails and sections with all accessories—railways, water service, loose tools, &c.—cost about £4 to £4 10s. per ton of output of finished rails or structural steel, and that the actual cost of a similar plant in 1910–12 was about £6 10s. to £7. The costs vary in different districts and with different sites, depending upon foundations and other local conditions, and I have detailed costs of plants built about 1912 which give a considerably higher figure than £7 per ton. I think if we take £4 5s. per ton for 1890 and £6 15s. for 1912, we shall be well within the mark, for, if anything, the difference in costs between the two dates is greater than this. In America the cost of a modern iron and steel plant complete with blast-furnaces in 1910–12 was distinctly higher than in this country, and is given by different engineers as from £9 to £10 per ton of output. Some give an even higher figure.

Based on the assumption that the capital costs were £4 5s. in 1890 and £6 15s. in 1912 per ton of output, and taking the low figure of 8 per cent. to cover both repairs and depreciation, it means that the charge for depreciation was 10s. 9d. per ton of output in 1912, as against 6s. 9d. in 1890, an increase of 4s. per ton.

This shows an increase of 58·5 per cent. in depreciation and repair charges per ton of finished product during 1890–1912, and is equivalent to 3 per cent. on the capital invested in 1912. The charge of 10s. 9d. per ton for depreciation and repairs on every ton produced includes nothing for interest on the capital invested, and if we include the modest return of 5 per cent. for this, the charge per ton of product becomes 17s. 6d., whereas the charge in 1890 would have been only 11s. per ton. This does not allow for any interest on working capital, as distinct from capital invested in plant.

The increase in capital cost is to some extent explained by the general rise in prices of all materials, but when allowance is made for this, I think, in view of the great increase in output, we might reasonably have expected that the capital cost per ton of output would have decreased between 1890 and 1912. This capital charge of 17s. 6d. per ton refers to 1912, and, in view of the large increase in costs of plant since that date, it would be so much higher to-day, that this question of keeping down capital expenditure is of very much greater importance than it has been at any time in the history of the industry.

The effect of increase in capital expenditure is further emphasised if we consider the time required to turn over the capital. With every increase in capital cost per ton of output, the time required to turn over the capital is increased, and the earning power is correspondingly reduced.

Expenditure on plant may be justified if it reduces manufacturing costs, either directly by the reduction of labour costs, the reduction of the quantity of materials required, the increase in the output or the improvement of the quality of the product, or indirectly by the improvement of the working conditions. In some cases the demand for an improvement in quality or a greater variety of products may justify increased capital expenditure, even when there is not only no decrease in working costs, but an actual increase. The gradual replacement of the basic Bessemer process by the basic open-hearth process, which is the present tendency all over the world, is a case in point, as, notwithstanding the increased cost both in capital expenditure on plant and in manufacturing costs, the greater control in respect to the quality and the greater elasticity of the open-hearth process have justified the change.

Another case is that of the replacement of the old beehive coke oven by the modern by-product coke oven plant. The capital cost of the modern coke oven plant per ton of annual production was in 1912 about 13s. per ton, as against 3s. per ton for the old beehive type of oven, but the greatly increased yield of coke, the recovery of by-products and general reduction in working charges, have justified the increased expenditure.

I fully realise that very large expenditure has been and must always be necessary in a progressive industry and that it is absolutely essential, if we are to hold our

* Condensed.

own in competition with the world, that money must be continually spent not only to maintain and improve the efficiency of our existing plants, but also to erect new plants to keep pace with new developments.

The real question, however, is not the actual expenditure, but the relation which the expenditure bears to the costs of production, which latter are so appreciably affected by the charges for depreciation and repairs.

I submit it is a reflection on steel works practice that not only in this country, but all over the world, notwithstanding the very greatly increased outputs, the capital cost per ton was considerably higher in 1912 than in 1890; and it is a matter deserving the most serious consideration that it has not been possible to build a works embodying all the essentials for the most economic production, at a cost per ton of output in 1912 at least approximating to the costs in 1890.

Whether I am right or wrong in thinking that our capital expenditure per ton of finished material has been too high, we are faced to-day with the fact that heavy capital expenditure has been incurred. Short of building new plants, all we can do now is to make such additions and alterations to our most modern plants as are absolutely necessary to ensure efficiency, and to utilise these plants to the best advantage, and I think we may usefully consider whether everything possible is being done in this latter direction.

In a modern steel plant, if it is to operate to the best advantage, it is essential that the most suitable material must be supplied for use in each department. Thus, coke which will give the best results in the blast-furnace, suitable coal for the producer, suitable pig iron for the open hearth, ingots to nearest possible weight to meet the particular requirements of the mill at the moment should be supplied.

On the Continent it is a common practice regularly to supply pig iron for the basic Bessemer and open-hearth furnaces with 0·5 per cent. or less of silicon and low in sulphur, whereas in this country, so far as I know, there are few, if any, open-hearth furnaces which are regularly operating on special pig iron of this composition. I am fully aware that with some of our ores it is particularly difficult to make a low-silicon and low-sulphur iron, and that it will cost more to make; but I am also aware that such an iron costs far less to convert into steel. Although there may be great difficulties, I am not prepared to admit it is impossible to produce such pig iron, even from Cleveland ore. To produce such a pig iron regularly will necessitate the use of some manganiferous ore, and, what is very important, the crushing and sizing of the iron ore to pass a 3in. ring, and the most careful control of the furnace operations. It will require the closest attention to ensure the proper mixing and regular charging of the ore burden, careful adjustment of the limestone to give a free-running slag with a high lime content, and the most careful control of the temperature and volume of blast.

In our general blast-furnace practice I believe considerable improvement is possible by following the American practice of blowing by volume instead of by pressure, by crushing the ores to pass a 3in. ring, and by giving greater attention to detail in charging the furnace, to the combustion of the gas in hot-blast stoves, and to controlling the temperature of the blast.

The production and economic use of gas is of such importance that I am convinced that it would pay many of our works to have a highly trained technical man to act as fuel superintendent, who should devote his whole time to the supervision of the gas production and its effective combustion in the open hearth, the mills, furnaces and under the boilers. A saving of 25 tons of coal per week would pay his salary. It would require a man of exceptional qualifications, as each departmental manager must necessarily have control of his own furnaces, and unless the fuel superintendent had great tact and were able to gain the confidence and enlist the co-operation of the departmental managers, it would be impossible for him to obtain really satisfactory results.

To obtain good results fuel suitable for gas production must be supplied, and before contracts for coal are placed the fuel superintendent, or whoever is responsible for the producers, should be consulted as to which fuel obtainable in the district gives the best results. The mechanical conditions, the type of coal, whether free-burning or coking, should be considered, in addition to the percentage of ash present.

Another matter which does not always receive the detailed attention which it deserves is the yield both from the open-hearth furnace and the mills. From records received from different works, in the case of rail mills, I find that the yield of good rails per ton of ingots rolled was no greater in 1912, and I think I may say is no greater to-day, than it was in the early 'nineties. It may be that the present yield is as much as can be obtained under the specifications to which we have to work, but it seems far from satisfactory that the yield has not increased since 1890, and I think there are possibilities of improvement in this and other directions by more systematic control and closer attention to detail.

The economic production of iron and steel depends upon many factors, and, amongst others, one of the most important is the size of the plant. It has been stated by men of wide experience that to compete successfully under modern conditions, a plant producing rails and structural steel must have an output of at least 10,000 tons of finished material per week, and some insist upon an even larger output. This may be true in countries like America, where the home market is a very large one and able to absorb the greater part of the production, but I am extremely doubtful about it being true in this country. The economic size of the plant largely depends upon the special conditions, and provided the output is large enough to carry the necessary overhead charges to maintain a staff of the best technical and commercial men available, this is the factor which largely determines the economic size. Little, if anything, is to be gained by increasing the size of the plant when this condition is met. When a works increases above a certain size the efficient control becomes more difficult and leakages are liable to occur, and unless it can be kept operating at or near its full capacity, the capital charges and the increase in manufacturing costs become a most serious matter.

Conditions have changed during the last forty years. The modern works is not now a works carrying out one operation, but a combination of works, and the key to success is an organisation which will ensure the closest co-operation between the departmental managers. These men must not regard their departments as separate units, but as integral parts of the whole, and each must realise that the one thing essential is to subordinate his particular department to the interest of the works, the object being by the most effective team work to produce the maximum amount of finished material of the highest quality at the minimum cost.

To face the competition of the future the industry will need men of the greatest ability the country can supply; on the technical side, highly trained men whose practice is based upon experience controlled by sound theoretical knowledge, and on the commercial side highly trained men with a wide knowledge of fundamental business principles. It is for those at present in control to offer such a career, both on the technical and the commercial side, as will attract the most capable young men in the country, so that the future captains of our industry may be trained men of affairs, with knowledge, sound judgment, and a sense of proportion which will enable them to subordinate the part to the whole, and so ensure that co-operation between the different departments which is absolutely essential to success.

High-voltage Outdoor Transformers

DURING a recent visit to the works of Ferranti, Ltd., at Hollinwood, Lancashire, some interesting transformers were brought to our notice, including some 13,330 kVA 110,000-volt units for the transmission system of the Cia Hidro Electrica Volcan, Chile, South America. These transformers are 50-cycle, three-phase units with a ratio of 110,000/1200 volts between phases, and they are star-delta connected with minus tappings on the 110,000-volt winding to give 107,500, 105,000, 102,500 and 100,000 volts. As will be gathered from the illustrations on page 496, they are of the Ferranti standard double-wound core type and they are rated in accordance with the standardisation rules of the American Institute of Electrical Engineers. They are capable of giving the specified output continuously when operating at 110,000 volts at an altitude of 4250ft. above sea level, and for short periods they are capable of being operated at 10 per cent. over pressure. The neutral point of the 110,000-volt winding is solidly earthed, and the insulation to earth is graded down from the line to the neutral connections. With their cooling equipment the transformers have been designed for outdoor service, the following items having been supplied with each unit:—Three weatherproof 110-kilovolt bushings, a three-phase Ferranti patented oil and compound filled cable box suitable for the three single-core 12,000-volt cable connections, a conservator tank with a Ferranti patented oil-sealed breather, four wheels with inside flanges, two oil circulating connections, a sampling valve, a main oil drain valve, cooling equipment, an oil flow indicator, and a dial type thermometer fitted with alarm contacts.

Transport considerations fixed the maximum permissible weight of any single piece of apparatus at 15 tons, but the total weight of each transformer, including the cooling equipment, but excluding the oil, is 40 tons. It was therefore necessary to provide for the dispatch of the unit in sections and for its re-assembly and drying-out on site. The overall dimensions of the tank also made it necessary, for the purpose of transport, to divide it into two sections. The 110,000-volt terminal is of the oil-filled porcelain type, the flange which is connected to a cylindrical shield inside the terminal forming the earth electrode. The conductor consists of a highly polished steel tube, and the dimensions of this conductor and shield are so designed as to control the electrostatic field and to render it as uniform as possible, and free from local areas and high flux density. The porcelain body is not used as insulation to increase the dielectric strength of the terminal, but it merely acts as a support for the conductor and the oil case. Since the dielectric strength or permittivity of porcelain is much greater than unity, it will seriously distort the electrostatic field. The shape of the porcelain is, however, carefully designed so that its surface conforms with the direction of the electrostatic field, and the stress in the neighbouring air is not therefore increased, and corona at low voltages is not experienced.

The main insulation of the terminal consists of oil and solid insulating barriers, the dimensions of these two components being chosen so as to render the radial dielectric field as uniform as possible by taking advantage of the permittivities of the material. Apart from this feature, however, this combination of oil and solid barriers is the best and most reliable means of insulation at present known.

All joints in the core are interleaved, whilst the yoke clamping framework is held by four large insulated square bolts keyed into each corner. The laminations are cut to receive them, and with this arrangement no tie bolts between the top and bottom yoke are required. The advantages of this form of construction, the makers point out, are very real, because it is extremely difficult to insulate vertical tie bolts from a 110,000-volt winding, not to mention the fact that such bolts add to the stray losses. With a view to facilitating the dismantling and assembly of the yoke, the joints between the core leg and yoke are stepped, and specially made templates also afford additional help in the assembly of the large cores on site.

The windings are of the standard circular concentric type. The low-tension winding—see Fig. 1, page 496—is a single layer helical coil consisting of several strands of copper ribbon in parallel, whilst the high-tension winding is built up of disc-wound coils. The main insulation between the high-tension and low-tension windings and between the windings and the frame consists of a combination of oil and solid barriers, the main consideration being to control the dielectric field so as to avoid uneven stressing of the material. The dielectric field is controlled so as to render the potential gradient as uniform as possble and to reduce to a minimum the electrostatic stresses between the windings and the framework and between the internal parts of each winding. The windings are designed to give a high factor of safety to incoming transient high voltages of steep wave front which result from switching operations, &c. Guard rings and suitable insulation between turns and to earth serve under such conditions for controlling the distribution of potential through the windings. Since creepage insulation is dependent on the condition of the oil and is affected by sludge or foreign matter, it has been avoided. Moreover, it has a much lower impulse ratio or time lag than solid insulation, and does not therefore present so large a factor of safety when stressed under transient high voltages.

The thermal design is based on the results of exhaustive research work and actual transformer tests. The oil ducts are designed, as regards size and disposition, so that at all points they have the maximum effect in the way of assisting the transmission of heat from the winding and core to the oil, the cooling being uniformly effective throughout the winding. As the oil circulation is positively distributed throughout the whole of the transformer, local hot spots and dangerous temperature gradients are avoided. With a view to determining the mechanical stresses on the coils when subject to short circuits thorough investigations were undertaken and the design of the coils was based upon the results of those investigations. As far as possible the windings are electro-magnetically balanced. The Ferranti spring coil support has been fitted at the centre of the high-tension winding, where it causes the minimum disturbance to the magnetic balance. Each spring is co-linear with a column of spacers and even distribution of the compression is automatically secured. As the axial components of unbalanced short-circuit stresses act in the same directions on the coils as the pressure of the springs, there is no tendency for the latter to compress under short-circuit conditions.

The Ferranti spring support has been thoroughly tested and oscillograph records were taken of the voltage and current. The crest value of the short-circuit current of a 1200 kVA 5500/440-volt 40-cycle transformer reached 18·4 times the full-load value, which meant that the mechanical stresses on the windings and coil supports were 338 times the normal value. During the test, however, the transformers showed no signs of stress nor sign of mechanical strain, movement of the windings or disturbance of the structural work after the transformer had been lifted out of its case for the purpose of examination.

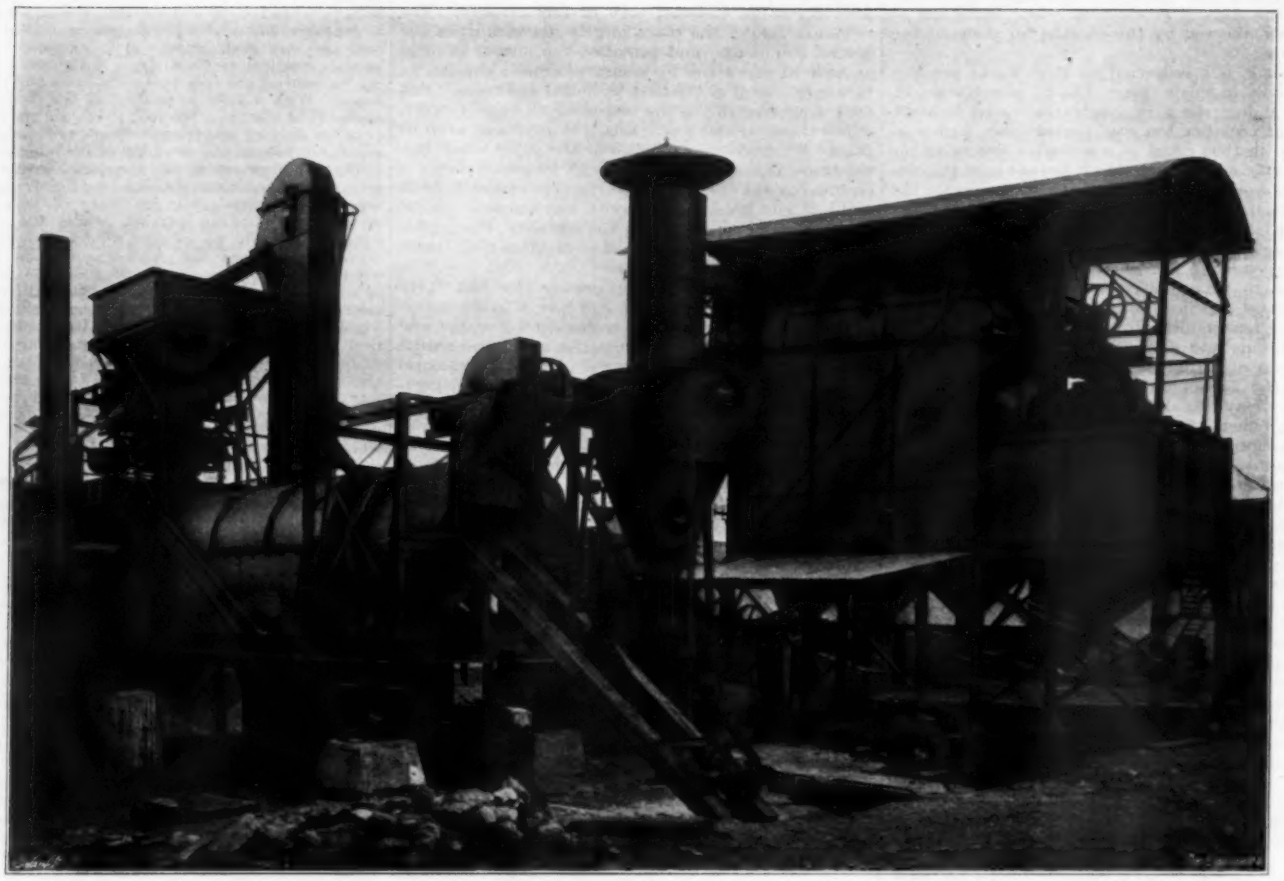
Tappings for 107,500, 105,000, 102,500, and 100,000 volts have been brought of the coils of the 110,000-volt winding and connections between these tappings are made by means of the maker's tapping switch (Fig. 2, page 496), which is operated when the transformer is out of circuit. Up to the present these switches have been fitted to transformers with an aggregate capacity of 800,000 kilovolt-ampères, and they are said to have worked perfectly satisfactorily. The special features of this system of tapping charging are: (*a*) The switch is at the same level as the tapped coils, thus making it unnecessary to cleat any connections from the coils to the switch contacts; (*b*) on account of the liberal insulation, a pressure of 70 kilovolts can be dealt with between the adjacent contacts, which, of course, are under the oil; (*c*) the switches have self-cleaning and aligning contacts; (*d*) the switches can be operated externally; and (*e*) it is impossible to lock the switches in the "off" position unless they are on the proper contacts.

The cooling equipment is designed for outdoor service and, as shown in Figs. 3 and 4 on page 496, it is mounted on the transformer base. The equipment forms a compact and self-contained unit and is claimed to offer several advantages over the usual arrangement. It occupies less space, and all the pipe work required can be fitted between the cooler and transformer at the works. The simplification of the oil circuit is also claimed to reduce the running costs. The equipment consists of an oil cooler, oil pump and motor with all the necessary pipe work, and, as nuder no conditions can the water pressure in the cooler rise above the pressure due to the static head, all possible chances of the water leaking into the oil are eliminated.

The contract included the erection and drying out of the transformers on site, and the core and windings were dried out separately from the oil. Air at the requisite temperature was blown through the transformer whilst it was in the tank, and, to remove air pockets in the winding insulation, the air was exhausted from the tank by means of a rotary pump, the tank being constructed to withstand a pressure of 15 lb. per square inch. The operation of blowing hot air through the transformer and exhausting it from the tank were carried out alternately until the resistance of the insulation had attained a steady value, great care being taken during the process to prevent undried air entering the tank. The dehydrating and cleaning of the transformer oil was carried out by means of oil filters fitted with the necessary heating elements.

ROAD METAL PLANT AT BRIGHTON

MILLARS' MACHINERY COMPANY, LTD., LONDON, ENGINEERS



Road Metal from Household Refuse.

For some time past the Corporation of Brighton has incinerated all the household refuse collected in the district and has disposed of the resultant clinker and scrap as well as it could; but it was obvious that these materials might be turned to better advantage. A plant for the purpose was inspected by many of those interested in such subjects, on the 29th ult. It is illustrated in the accompanying engraving, and it has been put to work to turn the clinker into a useful road-making material, while the scrap iron associated with it is baled and sold.

On this occasion we will not deal at any length with the incinerating plant, which is by Heenan and Froude, as its general principles are familiar to our readers, neither does the hydraulic baling of the scrap iron need elaborate description; but it was noteworthy, on the occasion of our visit, that the refuse delivered at the destructor yard contained a very large proportion of both paper and scrap iron, such as tin cans, old bicycles, bedsteads, &c. It is evident, in fact, that the Corporation aims at encouraging householders to clear out any waste material and send it to the destructor rather than encumber the town with useless rubbish.

The refuse is burned in very simple furnaces and provides more than sufficient heat to generate all the steam for motive power about the plant, while the temperature of the fires is such that practically nothing but iron and fused clinker are withdrawn at the bottom. The major part of the iron is separated from the clinker by hand, and is baled in a hydraulic press for sale. The clinker is sent to a covered yard alongside the plant we illustrate for conversion into road-making material. It arrives there in lumps, sometimes bigger than a man's head, and still including a certain proportion of scrap iron, which would be detrimental to its use as a road metal, so the first process is to crush, screen and separate it. The plant for this purpose, and the subsequent production of a bituminous road material, has been supplied by Millars' Machinery Company, Ltd., of Pinners' Hall, London, E.C. 2.

In view of the fact that there is a considerable local demand for crushed clinker, for various purposes, the plant is divided into two distinct units—one for reducing and cleaning the clinker, and the other for drying and mixing it with melted bitumen to form a road surfacing material. The whole of this plant has been installed on a piece of rising ground, so that the raw clinker can be easily man-handled on the lower level, and the crushed material can be carted away at the higher level. The vertical distance between the two levels is overcome by an elevator. In the case of hot bituminous road material delivery is effected at the lower level again, as rather more headroom is then required. The view which we reproduce, by the way, was photographed from the higher roadway.

The clinker, arriving from the sorting yard on the lower level, is first dumped into the hopper of a 7in. by 12in. jaw crusher, which reduces it to about 1¼in. to 1½in. size. The crushed material falls into a pit below, from which it is picked up by the elevator already mentioned. This elevator is about 40ft. high and has buckets 9in. wide. It takes the crushed clinker to the inlet end of a rotary screen 3ft. in diameter by 15ft. long, which is perforated to pass ¼in., ⅜in. and 1¼in. stuff into appropriate hoppers below, the outlets from which are sufficiently high to allow jubilee wagons to be run beneath. The storage capacity of the hoppers is 40 tons.

Any iron which may be contained in the clinker is separated out in two stages by magnetic separators, by the Rapid Magnetting Company. At the feed end of the screen there is a separator of the yoke type, which embraces half the circumference of the drum and takes out approximately 70 per cent. of the iron in the clinker. This iron drops down a shoot to the lower level. At the discharge end of the screen there is another separator of the magnetic pulley and band type, which receives the rejects. Any iron or pieces of clinker containing iron, are removed by this separator and delivered down a side shoot. The efficiency of this apparatus may be judged by the fact that a piece of clinker weighing at least an ounce and containing the remains of a small wire nail is not allowed to pass. The separators are operated by a special controller, which was described in THE ENGINEER of May 22nd, 1925. The remaining clinker drops into a pair of 24in. by 14in. rolls, and is crushed to ¾ size before falling into a special hopper below. The whole of the plant is roofed over and is driven by a 45 brake horse-power vertical steam engine, with a Pickering type governor, working at 159 lb. steam pressure.

The second section of the plant, for converting the crushed clinker into bituminous road material, comprises a standard Millar asphalt plant, and is seen in the foreground of our illustration. It has a capacity of from 8 to 10 tons per hour, and as a machine of this type was fully described in our issue of December 11th, 1925, it is not necessary to enlarge upon it here. There are, however, one or two special features about the plant under review. For instance, it is obviously unnecessary to provide travelling gear, so the whole machine is built up on a substantial framework and concrete foundation. The connections between the frame and the foundation are effected only at the extreme ends, and take the form of pivots at one end and screw jacks at the other. By these means it is possible to alter the inclination of the rotary drying drum, and increase its pitch in summer time, when the aggregate is drier, so that the output of the machine is increased. As concerns output, that is, of course, dependent on the supply of material by the feed conveyor, and we were much impressed at the high service which is obtained in this plant by running a small conveyor at a high speed.

Another special feature about the installation is the Davidson cyclone dust separator, which can be seen in our engraving. The suction fan of the dryer delivers into this cyclone, and we noticed that although the machine had been running for some weeks very little dust had accumulated on the surrounding roofs. There is a separate engine, of 25 brake horse-power, for driving the mixing plant.

The melted bitumen is supplied by two "kettles," each of 950 gallons capacity, which are so arranged that one man can conveniently fire their furnaces and that of the dryer from one position. The bitumen is delivered to the mixers by a gear type pump, and arrangements are made so that when bitumen is not being discharged into the weighing bucket it is kept in constant circulation to and from the kettles to insure that it will not cool down and congeal in the pipes. In this connection it is noteworthy that the temperature at the outlet of the dryer is, according to the pyrometer which we read, some 1100 deg. Fah., so that the road material is delivered hot enough to be conveyed some considerable distance to the site of operations before it is too cold.

In the Millar plant there are, as we have explained in our previous description, two mixers for stirring the aggregate and bitumen together, and they have separate delivery shoots. This arrangement has the merit that a job can be supplied alternately with binder material and with fine carpeting without it being necessary to make any alteration to the gear of the mixer. At the Brighton plant the finished road material is delivered down either one of two shoots to lorries running on the low level roadway.

Diesel Engine Users Association.

At the meeting of the Diesel Engine Users Association, which was held on Friday of last week, April 29th, a paper by Mr. Oswald Wans, M. Inst. C.E., M.I. Mech. E., on "Further Developments in Mechanical Injection Oil Engines," was read and discussed.

The author said that during the last few years marked improvements had been effected in both two and four-cycle engines of British design and manufacture. The call for vertical engines had resulted in the building of larger units, and to-day four-cycle land engines, ranging up to 1000 B.H.P., and two-cycle marine engines up to 5500 B.H.P., were available. These sizes, however, did not represent the possible power limit.

Some five years ago, when he had read a paper before the Diesel Engine Users Association on "Some Recent Developments in Mechanical Injection Oil Engines," he had hazarded the opinion that the system would be more widely used. Not only had that proved true, but there were indications of its still more extended application. That seemed inevitable in view of the simplicity, proved reliability, and efficiency of the system.

In reviewing the progress made in the mechanical injection, two-cycle engine, the outstanding feature was the adoption of higher compression pressures; in fact, that departure was mainly responsible for the advance that had been made. Formerly pressures of 150 lb. to 180 lb. per square inch were general practice, and necessitated the use of an unjacketed hot bulb, but with the advent of higher pressures that unsatisfactory feature had been discarded. Probably the first engine to break away from general practice was that built by Plenty and Son, Ltd., in 1920, in which a compression pressure of 220 lb. per square inch was employed.

In the new Vickers-Petters' engine the compression pressure had been carried higher, being about 320 lb. per square inch. The cylinder head was completely water jacketed, the jacket over the combustion chamber proper being in the form of a large separate detachable cover which could be completely removed in order to clear out sediment from the water space. A small pocket was provided suitable for a starting plug, either of the electric or lamp-heated type. Many improvements had been effected in the general design, and a marked reduction had been made in the consumption of lubricating oil, which was generally high in two-cycle engines of the crank case scavenge type.

The progress made with four-cycle engines of the

mechanical injection type had been marked. Prior to 1921 mechanical injection had been almost entirely confined to horizontal engines, but the requirements of central power stations had since rendered this type unsuitable, the demand being for higher rotational speeds and reduced floor space. On the other hand, for certain classes of work, the greater accessibility and slower speeds of the horizontal type of engine still offered advantages which were considered sufficient to justify engines of this class.

The author gave some interesting information concerning special features of the vertical engines which are made by Ruston and Hornsby, Ltd. The new fuel distributing gear, which comprises a single fuel pump with a mechanical distributor,* was described and illustrated, and reference was also made to a new type of cylinder head for the large sizes of engine, which consists of a steel flange of symmetrical shape and uniform thickness, to which the upper part of the cover is bolted. Referring to the first Ruston mechanical injection oil engine installed at Maidenhead, which was described in a paper read before the Association by Mr. C. O. Milton on July 9th, 1925, the author said that there had been no increase in the fuel consumption of that unit, which had, on the contrary, tended to improve. The average running conditions showed a consumption of about 0·46 lb. per B.H.P. hour, and a brake thermal efficiency of 31 per cent. The full-load consumption was 0·614 lb. per kilowatt-hour, or 0·41 lb. per B.H.P. hour, with a brake thermal efficiency of 35 per cent.

Finally, the author considered the possible thermal efficiency obtainable in practice, based on the air standard. This he assessed at a possible maximum of 40 per cent. The thermal efficiencies of the Doxford and Maidenhead engines on this basis were 37 and 35 per cent. respectively, which showed that we were within measurable distance of this computed maximum, and also to what extent improvement may be expected. The Beardmore mechanical injection engine, designed by Mr. Alan Chorlton, was referred to as having given on an hour's trial run a consumption of 0·355 lb. of oil per B.H.P. hour, which was equivalent to about 39 per cent. brake thermal efficiency.

The realisation of such high efficiencies, it was pointed out, must be largely dependent upon the heat-resisting properties of the materials at the disposal of the designer, and although considerable strides have been made in this direction, there was still much scope for investigation. The closer working between the metallurgist and the engineer had in recent years produced better materials and designs, with marked improvement in the life of castings subjected to high stresses and temperatures. Nevertheless further progress was at the present time restricted by this factor.

It was true that the maximum computed efficiency of 40 per cent. allows of a possible 15 per cent. improvement in performance of the average present-day engine, yet one was led to speculate as to how long heat losses amounting to over 60 per cent. of the total contained in the fuel will be accepted with complacency. A bold attempt had been made in the Still engine using mechanical injection to recover the heat given up to the water jackets, and in this way a brake thermal efficiency of about 39 per cent. had been realised under sea-going conditions. That principle was very interesting, for it was evident that by reclaiming heat which would otherwise be uselessly dissipated, a gain in thermal efficiency must result.

Whether further progress would be along these lines, by a modification to the known cycles or by entirely revolutionary means, was, Mr. Wans thought, a question that for the present must remain unanswered. In the meantime development would be, in the author's opinion, mainly in the perfecting of mechanical details, and in rendering the internal combustion engine—whether of the mechanical or air injection type—an even more reliable power unit.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Unsatisfactory Position.

MANY Black Country forges and mills are idle, and throughout the Midlands and Staffordshire it is daily becoming increasingly difficult to keep the works in employment. Most of them are only working intermittently, and periods of activity are getting shorter. Demand alike for raw materials and finished goods is poor. There is no confidence in the stability of current values. Industrialists who have to meet international competition realise that lower production costs and reduced selling prices are essential if there is to be any return to normal conditions and trade recovery in the basic industries, and the manufactures which depend upon them. They continue to buy most cautiously, such orders as they give out representing minimum current requirements. No material is being put into stock, and forward contracting is out of the question. Inquiries continue to circulate with a view to ascertaining producers' lowest terms, but they fail, in most instances, to be followed by tangible business, buyers considering values too high. This week the pressure for better terms has persisted, but, apart from a slight easing in pig iron, values remain substantially where they were a week ago. Some South Staffordshire works specialising in the requirements of the shipyards and special branches of engineering are experiencing an improved demand, but, generally speaking, orders for new business are not coming through in sufficient volume to maintain even the present output. At the iron and steelworks unless demand expands in the near future, some curtailment will have to be considered. The outlook, I regret to state, is far from encouraging.

Manufactured Iron.

Demand for Staffordshire bar iron continues meagre, and the finished iron department at the weekly meeting showed little animation. The marked bar makers are kept fairly well employed by shipbuilding and engineering demands, and some of the mills have a substantial tonnage of work to get through before they will have cleared off arrears, but little new business is forthcoming. It is not considered that any change in prices which local makers could reasonably be expected to make, would stimulate demand. Quotations, therefore, remain unaltered, marked bars being at £14 10s., Crown quality £11, nut and bolt and fencing bars £10 5s. Wrought iron gas tube strip ranges in value from £12 10s. to £12 15s., according to the size of order and individual circumstances appertaining to the parties or business.

Steel.

Progress continues to be made in the steel department. Shipbuilders' and engineers' demands are improving, and the prospects for this section of the steel trade are considered to be brighter. Structural steel is being absorbed at a good rate, but new business is not coming in as well as might be expected. Midland constructional engineers are experiencing a quiet period as far as heavy projects are concerned. The business coming in relates mainly to small tonnages. Now that better supplies are available from native mills consumers are less inclined to buy continental material, although prices are so much lower. While native prices are upheld, however, there is not much confidence in the position, and all big scale transactions are being held back. On 'Change in Birmingham to-day—Thursday—steel prices were fairly maintained. Angles and joists commanded £7 15s. and £7 17s. 6d. for prompt delivery, while tees were 20s. more. Ship, bridge, and tank plates made £8 7s. 6d. upwards, boiler plates £11 to £11 10s., small steel bars sold at £8 10s., and mild steel billets at £7. Staffordshire hoops were quoted £10 10s. at works. Continental quotations varied little from last week's figures, billets being offered at £5 8s., and steel bars at about £6.

Raw Iron.

The efforts of Midland blast-furnacemen to induce suppliers of coke to lower their basis price of 22s. at ovens have been unavailing. Indeed, as many of them, rather than enter into contracts at present rates are buying from hand-to-mouth, they have to pay anything from 22s. 6d. to 24s. for their supplies. On their part, however, they have been unable to withstand the pressure brought to bear by consumers of pig iron for lower prices, and many of them have conceded a further 6d. to 1s. per ton. Although in one case at least Derbyshire No. 3 foundry is maintained at £4 2s. 6d, in offers where producers have a considerable proportion of their output to find openings for, £4 1s. and even £4 would be readily accepted. Northamptonshire foundry is quoted £3 18s., and North Staffordshire £4 1s. 6d. It is difficult to determine forge iron values, so little business is being transacted. The prices named are largely nominal. East Coast hematite has depreciated further, and was on offer in Birmingham to-day at £4 1s. f.o.t. for mixed numbers. Production in this area continues on a fairly good level, and although many smelters express doubts as to whether the standard can be maintained, restriction of output has not yet been resorted to. Smelters still entertain hopes of being able to persuade coke suppliers to give them better terms.

Galvanised Sheet Values.

Recent contracts for sheets all appear to have been for small tonnages, and while the mills have just about sufficient work to maintain operations, they are anxious to secure new business to replace existing contracts as they are worked off. To this end many of them have this week further shaded prices, especially where export business was concerned. Buyers claim to have been offered supplies of 24-gauge galvanised corrugateds at £14 10s. f.o.b. Liverpool. Most sellers on 'Change in Birmingham to-day, however, asked £14 15s., while others were not prepared to give way even to this extent. Quotations range from £14 15s. to £15. In practically all instances where thin gauges were concerned mills insisted that the extras should be calculated on the £15 basis or higher.

Industrial Developments.

News of new industrial developments is always welcome and particularly so at the present time in the Black Country area, where many well known heavy engineering works have during recent years been closed down. It has this week become known that the Union Steel and Manufacturing Company, of Wolverhampton, has secured a site of eight acres in extent just outside the borough boundaries on which it proposes to build a new factory. The company manufactures bright steel bars and high-class engineers' nuts, bolts, studs, and special machine parts. It already has two factories in Wolverhampton, and the new factory at Fordhouses will be an extension of the two existing works. Plans have already been approved for a building 650ft. by 60ft. on the new site, and it is hoped eventually to utilise the whole of the eight acres for building purposes.

Salop Sugar Beet Factory.

Further details of the £460,000 sugar beet factory which is now in course of erection at Allscott, near Wellington, Salop, are now available. It is understood that there are to be twenty-seven buildings, apart from the main sugar works, the dimensions of which will be 300ft. by 100ft. by 75ft. high. The main plan of construction provides for steel framed building, with concrete floors, &c., The remaining buildings include power house, boiler house, sugar store, pulp drying plant house, pulp shop, repair shop, lime and coke stores, lime kiln, offices, loco. shed, garage, gate house, and various stores and discharging stations. The scheme includes the putting in of sidings from the main L.M.S.—G.W.R. joint line to deal with traffic expected during the season to amount to 300 trucks daily. A quarter mile pipe line is to be provided, together with a pumping station, and pumping plant in duplicate, to ensure the water supply. The provision of a sewage disposal works and a power plant to provide the electric lighting is also contemplated. The factory, when complete, will be one of the most modern of its kind in the United Kingdom, and will be capable of dealing with 800 to 1000 tons of beet daily.

Black Country Miners' Wages.

At a meeting of the Joint Board last week it was decided that for the month of May wages of miners in the South Staffordshire and East Worcestershire area should remain as in April, viz., 57 per cent. on the basic rate

Unemployment.

It is satisfactory this week to have to record that the returns of unemployed persons in the Midland area show a slight decrease. The total number of men, women, boys and girls out of work is 159,816, as compared with 161,806 a week previously. While the latest total represents a decrease of 1990 during the past fortnight, it shows an increase of 4368 when compared with the first week in April. Now that the turn has come, however, it is hoped shortly to improve upon this year's best figures.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The Industrial Outlook.

ON balance, the position of the engineering industries has shown little change during the past month. Reviewing the situation in the course of a general industrial stocktaking, the *Monthly Record* of the Manchester Chamber of Commerce states that the electrical firms undertaking big jobs are pretty well occupied. Foreign and colonial orders are only obtainable by quoting low prices, but the condition is met, and the business is helpful, even when it is not particularly profitable in itself. Home demand, without being large, is by no means negligible. Some sections of the electrical engineering industry, however, are quiet. Constructional engineers are now in the best part of the year for their trade, and generally speaking they are well engaged. The same may be said also of the motor vehicle industry. Most textile machinists, however, are having a dull time, although artificial silk machinery is in fair demand. The lull in the cotton trade has made it impossible for the spinners and manufacturers engaged in it to place many orders, and foreign firms are under much the same disability. Machine tool makers, too, are not getting enough business to keep their works fully employed.

£250,000 for Electricity Mains.

Further borrowing powers to the extent of £252,450 are sought by the Manchester Electricity Committee, acting on a report recently presented by Mr. H. C. Lamb, the chief electrical engineer and manager. The growing demand for electricity has necessitated the laying down of various classes of mains, and it is for this purpose that the Electricity Committee is recommending the City Council to apply to the Electricity Commissioners for additional borrowing powers, the present powers for mains being on the point of exhaustion. Borrowing powers to the extent of £155,500 altogether are the subject of a recommendation by the Finance Committee. The sum of £135,000 is in respect of the reconstruction of the light railways in Middleton recently purchased by the Manchester Tramways Committee from the Middleton Electric Traction Company, Ltd., whilst the balance of £20,000 is the estimated cost of the construction and equipment of a motor omnibus garage for the accommodation of the vehicles which the Tramways Committee is employing on the numerous services now in operation.

Non-ferrous Metals.

Taking the non-ferrous metal market as a whole, the tendency during the past week has been steadier than it was during the period covered by my last report. The position, however, would appear to be still far from stabilised. In spite of continued expressions of faith in the statistical position of tin, for example, after a fair measure of recovery on an improvement in buying interest from United States consumers earlier on values had lost some ground on balance at the close of business last week-end, although in the opening days of the present week there had been a recovery to the extent of about £3 per ton in the case of spot metal. Forward positions, however, showed a slight additional loss, and at the time of writing are lower than they have been since the beginning of the year. The fact of the matter is that the outlook from the point of view of industrial consumption is anything but clear. Buying on domestic account continues on a disappointing scale, and the market seems to be uncertain as to the position in respect of overseas consumption, particularly in the United States. The latter factor has not been without its influence also on the copper market, although there has been a fair amount of buying during the week for use in the cable-making industry. The net result of the week's operations has been a further slight fall in prices, and the present tone of the market seems still to lack strength. Buying interest in the case of lead and spelter has been rather limited, but both of these metals have finished up pretty well where they were a week ago, in spite of minor fluctuations which occurred during the period under review.

Iron.

By far the most important event on the iron and steel markets since my last report has been the reduction of 5s. per ton in the selling prices of Middlesbrough foundry iron. The extent of the "cut" was the more surprising, in view of the fact that whilst other makes during the past month or so have been gradually but steadily falling, North-East Coast makers have maintained their quotations intact. The cause, apparently, is the recent growth in the competition from the Continent, heavy shipments having been landed at East Coast ports and disposed of,

* See THE ENGINEER, June 11th, 1926.

largely at the expense of Middlesbrough district makes. Apart from the actual reduction itself, rather more interest is being taken in the question of the effect on Midland foundry irons. The present price of about 88s. per ton, delivered in the Lancashire area for Middlesbrough No. 3, places it in a much better position to compete with Derbyshire and other Midland makes than it has been in for several years, and buyers are expecting that the next step will be taken by the Midland producers. What that will be, or rather its extent, is not yet known, but there is a widespread belief that the return to something approaching pre-strike prices, so far as the higher production costs will permit, will be more rapid than would otherwise have been the case. Under the circumstances, it is not surprising that there has, if anything, been a stiffening in the cautious attitude of buyers, and actual business has been on a very quiet scale. Values all along the line are undoubtedly easy, Derbyshire being quoted at 88s., Staffordshire at 89s., Scottish at about 100s., and hematite, both East and West Coast, at 93s. to 94s. per ton delivered in this district. There is only very moderate business activity in the case of finished iron, but prices remain at £11 per ton for Lancashire Crown bars and £10 for second quality material.

Steel.

There is little new in the steel position to be reported this week, except that buyers here are just as reserved as they are in the iron market, so far as the placing of actual new business is concerned. A fair amount of inquiry is circulating, but most of it seems to be with the object of testing prices. Certainly orders that have been placed this week have been for early needs, little attention being paid at this stage to buying forward. From £8 7s. 6d. to £8 12s. 6d.—the former figure being the more usual—is being quoted for ship and tank plates, joists and sections ranging from £7 15s. to £7 17s. 6d., bars from £8 5s. to £9, and boiler plates from £11 7s. 6d. to £11 10s. There has been little life in the market for continental varieties, and prices in most sections are noticeably weaker again. For delivery into this district, for cash against shipping documents, joists and sections are now on offer at about £6 per ton, ordinary plates at £6 18s. to £7, Siemens plates at £7 5s., steel bars at £5 15s. to £5 17s. 6d., sheet bars at £5 5s. to £5 7s. 6d., and billets at £5 to £5 2s. 6d. per ton. Buying interest in galvanised sheets remains of very limited extent, and values continue easy at about £14 12s. 6d. per ton f.o.b. for 24 gauges.

Scrap.

Prices of non-ferrous metal scrap are weak all round, in sympathy with recent falls in the new metals, and the demand in most cases is quiet. Selected gunmetal scrap is quoted at about £51 per ton, clean light copper at £56 10s., zinc at £25, lead at £26, brass rod turnings at £38 to £39, and heavy yellow brass at £44 to £45, for graded materials and including delivery to users' works.

BARROW-IN-FURNESS.

Hematite.

There is a slightly better tone in the hematite pig iron market, and customers are showing a better attitude towards makers. If anything, the orders cover a bigger period for delivery, and there is a tendency for them to become larger. The general requirements are bound to be fairly heavy for some time to come, but makers have not been able to secure big orders, owing to the fact that consumers have been holding off for lower prices. In view of the fact that coke has not been appreciably reduced, and iron remains about the same, it has been found impossible on the part of buyers to hold off any longer. There is still the chance of coke falling; in fact, fall it must sooner or later, but in the meantime orders are coming in, and it looks as if the present rate of production will be continued through the summer. There is even a suggestion of another furnace being put into blast in Cumberland. Output in the future will to a very large extent depend upon the requirements of the steel departments. The iron ore trade continues to be steady, and is likely to remain so as long as the iron trade continues on the present basis. There is a certain tonnage going out of the district, but it is not very heavy. The steel trade, as far as rails, sleepers and fish-plates are concerned, is quiet, and fresh orders would be welcome. In the hoop and small section mills a long run on contracts held and assured is certain.

Electricity Supply.

The Barrow Electricity Committee has at last secured permission to proceed with the additions to the present power-house. At first the Electricity Commissioners were opposed to the proposal, but have at last agreed to the extension, which will mean the installation of a 6000-kilowatt set. This extension, in view of the ever-growing demands of the district, is badly needed, and it replaces the original scheme to harness the Backbarrow Falls on the river Leven by means of turbo-generators, which was turned down after much negotiation.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Trade.

ALTHOUGH it is known that there is a good deal of work pending in the heavy steel trade, there is no hurrying to place it, users considering that the prices of pig iron and steel are too high, and that there is plenty of room for them to fall. As a consequence, two of the open-hearth steel furnaces, which had been working pretty well up to full capacity since the settlement of the coal dispute last year, have been closed down, and as the arrears of orders will soon be cleared off there will have to be a further curtailment of work unless a big buying movement soon develops. The furnaces may be able to continue as they are working at present up to the end of the month, but the prospects from the beginning of June are extremely doubtful. Prices are not quotably lower, but the pig iron makers have conceded just about as much as they can afford, the steel trade has granted a corresponding allowance, and it is difficult to see how there can be any further reductions until pig iron eases, and that, again, is dependent upon the coke market. That market, in turn, is influenced by the depressed state of the coal trade, the short time working at the pits, which is pretty general in this area, having resulted in a shortage of coking slacks. It is a vicious circle, and everyone concerned would welcome a return of the economic conditions which would enable it to be broken.

Special Steel Departments.

Most of the principal works making special quality steels have good order books. For high-grade tool steels there is an improving demand, and the motor industry continues to be one of the mainstays for many kinds of special steel. Substantial orders are being placed regularly. Makers of stainless steel are also busy. The use of that material is being gradually extended as the result of experiment and research, and more of it is being made than ever. Without doubt this year will create a fresh record. The proposed French tariff threatens to hit particularly hard the finer qualities of steel and articles made from them, and the Tariffs Committee of the Sheffield Chamber of Commerce has been giving careful attention to the proposals. Members of the Committee and representative firms in the city have been requested to supply precise data of the effect of the increases upon Sheffield trade, and the information will be submitted to the Board of Trade.

Cutlery and Plate.

The cutlery and plate trades remain extremely quiet, and the immediate outlook is none too promising. A fair amount of colonial business is being placed, largely for good-quality stainless cutlery, but the home trade is dull. In its monthly review, the Chamber of Commerce sees encouragement in the fact that the purchasing power of the community shows signs of expanding, and it is calculated that more new homes will be furnished this year than for many years past, the house shortage being much less pronounced. This involves a demand for goods, in addition to plate and cutlery, in which the district specialises. In the official report on the recent exhibition in Sheffield of foreign goods collected in various oversea markets, it is recorded that ninety-five representatives of local firms attended during the one day the goods were on view, quite a number of the manufacturers asking for the loan of samples in order that the types might be copied and competitive samples prepared. Altogether, fifty-nine patterns were borrowed for that purpose. Cutlery samples from the Argentine were lent several times over, and as they were the products of four countries the differences in design and quality were considerable. All, however, had proved good selling lines in the Argentine, and were therefore of value to Sheffield exporters. This particular exhibition was one of the series arranged by the Department of Overseas Trade in conjunction with the Chamber of Commerce, and the latter body incidentally has passed a strongly worded resolution of protest against the abolition of this Department, which has been sent to the Prime Minister and to the President of the Board of Trade.

Another Contract Goes Abroad.

I referred last week to the placing of an order in Holland by Mansfield Corporation, and this week I have to mention the placing abroad of another contract for a big public body in this country, Hull Corporation Telephones Committee having recommended the acceptance of a Belgian tender for 150 automatic table telephones. Tenders were invited, and seven British firms and the Belgian firm responded. The highest British tender was £522, and the lowest £475. The Belgian tender was £337 10s.

Sheffield Schemes.

The Finance Committee of Sheffield City Council has sanctioned the expenditure of £53,000 for the construction of four further units of plant in connection with the bio-aeration sewage disposal scheme, this amount being part of the balance remaining from a sum of £313,228, the total cost for the extension of the sewage works. This made provision for the erection of fourteen units of plant. With reference to the Sheffield Electric Supply Committee's recommendation to obtain authority to incur the expenditure necessary to proceed with the installation of an additional 20,000 kilowatts of generating plant at Blackburn Meadows, the general manager now reports that the Electricity Commissioners state that they are making a survey of an area, which includes Sheffield, and anticipate that they will be able to publish a scheme during the autumn of this year. The Electricity Commissioners have been informed that the Committee considers that further generating plant is urgently required to provide the increased demand anticipated in the near future. The quotation of the English Electric Company, Ltd., amounting to £4300, for the supply and erection of automatically operated traction sub-station equipment has been accepted.

Selby Beet Factory.

So satisfactorily has work proceeded in the erection on the East Riding side of the river at Selby of a sugar beet factory for the Selby Sugar Company, Ltd., that it is now hoped it will be ready by September instead of October. Beet for the factory is being cultivated on 8500 acres by 2000 growers.

Goole Water Tower.

The Goole water tower, a ferro-concrete structure which is claimed to be the largest of its kind in the world, has been officially put into service. It has a height of 155ft. 9in. from the ground level, and at the top carries an outer and an inner tank which have a holding capacity of 750,000 gallons. The diameter of the outer tank is 88ft. 9in. and the depth is 22ft. Surrounding an inner pilaster wall are twenty-four columns, all braced together with beams. Steel bars weighing 181 tons were used in the building. The approximate weight is 3550 tons, and the tanks can carry 3350 tons of water. The tower, which has taken over two years to complete, is part of a scheme costing £47,800 for the extension of Goole waterworks.

New Foundrymen's President.

Mr. Ambrose Firth, a director of the Brightside Foundry and Engineering Company, Ltd., Sheffield, has been appointed President of the Sheffield and District branch of the Institute of British Foundrymen. It will be an important year for him, as the annual Convention of the Institute will be held in the city from July 5th to 8th. Mr. Firth is a grandson of Mr. Ambrose Firth, who more than fifty years ago founded the Brightside Foundry and Engineering Company, now one of the largest, if not the largest, ironfoundries in Sheffield, and is a son of the late Mr. Thomas H. Firth, who was chairman of the company.

NORTH OF ENGLAND.

(From our own Correspondent.)

River Tees Developments.

THE Tees Conservancy Commissioners' great project for widening and deepening the river Tees, so as to make it capable of accommodating the biggest ocean liners, has received the unanimous approval of Tees-side shipowners, industrialists, and other payers of dues. The scheme also includes the reclamation of a large area of Seal Sands on the Durham side at the mouth of the river, which will be made available for works sites, wharves, &c., and will involve an expenditure of over half a million sterling during the next four years. Sir Hugh Bell, Bart., chairman of the Commission, explained at a conference this week that the liquid assets available totalled £120,000, leaving more than £400,000 to be raised by other sources. The Commissioners would levy such dues as financial conditions appeared to demand, but they were confident that increased revenues would meet the charges without any serious extra addition to the dues. The London and North-Eastern Railway Company has obtained the consent of the Commissioners to an extension of ten years for the reclamation of the land acquired by them at Lackenby as a site for a proposed new deep-water dock. This scheme, estimated to involve an outlay by the company of £2,000,000, has been shelved for some considerable time past owing to the industrial situation.

Cleveland Iron Trade.

An all-round reduction of 5s. per ton in Cleveland pig iron prices this week was not unexpected, but nevertheless it is welcomed by merchants and consumers. Force of circumstances has evidently brought about the reduction, the competition of other iron, both home and foreign, having put Cleveland brands practically out of the running. The ironmasters appear determined to win back some of the trade that has been lost, particularly in European countries, through high prices, and also to counteract the dumping of foreign iron into home markets at a price, it is asserted, that can hardly cover the cost of production. The 5s. reduction this week makes the third drop in prices since the beginning of the year, making a total of 10s., but the price of the standard quality is still 5s. above the pre-strike quotation. At 75s. No. 3 G.M.B. Cleveland pig iron is somewhat higher than the price of foreign foundry iron delivered in the Tees, and as the latter can be bought at 66s. to 68s. per ton f.o.b. Antwerp, it is still doubtful if any substantial business in Cleveland iron can be done with continental buyers. However, the reduction should at least stimulate the home trade, and lead to such an expansion of business as will at least obviate the curtailment of output. No. 1 Cleveland foundry iron is now quoted at 77s. 6d.; No. 3, 75s.; No. 4 foundry, 74s.; and No. 4 forge, 73s. 6d.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade is not much changed. Makers have been steadily reducing prices for weeks past, and having got down to 82s. per ton, as a quotation for mixed numbers, they report that there has been some expansion in the volume of business though the foreign demand is still limited.

Ironmaking Materials.

Little new business is reported in the foreign ore trade, but deliveries under running contracts continue on a very heavy scale, the imports to the Tees last month reaching 183,380 tons. Best Rubio ore is steady at 22s. per ton c.i.f. Tees. Good medium blast-furnace coke is still obtainable at 23s. per ton delivered at the works, though some of the Durham makers ask higher figures.

Manufactured Iron and Steel.

Producers of finished iron and steel are kept very busy, but while the tonnage output against running contracts is heavy, the dearth of new orders is causing anxiety. At the same time belief prevails that stocks of some descriptions in consumers' hands are becoming very low, and that resumption of buying may be experienced shortly. Whether the fall in pig iron prices will lead to reduction in steel prices remains to be seen. Many consumers are obviously expecting some concession, and are reported to be withholding orders.

Steel Trade Record.

The exports of manufactured iron and steel from the Cleveland district last month constituted a record in the history of local industry. The total for the month was 94,998 tons, compared with the previous record of 77,258 tons in March, 1926, and a pre-war monthly average of 60,000 tons. The exports were distributed to nearly all

the great ports of the world. To India and Ceylon alone over 21,000 tons of finished material were shipped. Nearly 11,000 tons went to Australia, 5402 tons to the Argentine, and 16,698 tons to Africa. The pig iron shipments, however, were on a very disappointing scale, the fact being that Cleveland prices are so high that local iron is virtually shut out of foreign markets. The total pig iron shipments for the month were only 11,326 tons, compared with 18,588 tons in March. The coastwise shipments fell from 11,593 tons to 4465 tons, whilst foreign shipments, which totalled 6995 tons in March, declined to 6860 tons. The aggregate shipments of pig iron and manufactured iron and steel in April thus reached a figure of 106,323 tons, which is the highest total recorded since May, 1924, when 135,294 tons were shipped.

Iron and Steel Imports.

Statistics presented at this week's meeting of the Tees Conservancy Commissioners showed the quantities of iron and steel imported to the river Tees during the past six months from continental countries, India, and coastwise, as compared with the same months a year ago and the corresponding period of 1913–14. Pig iron brought into the river to the end of April last totalled 74,876 tons, as against 35,055 tons a year ago, and 106 tons in the pre-war period. Crude steel bars, billets, blooms, slabs, &c., imported in the last six months reached 103,818 tons, as compared with 69,033 tons a year ago, and 24,134 tons in the pre-war period. The imports of plates, bars, angles, rails, sheets, &c., during the past six months totalled 29,552 tons, as against 7315 tons in the corresponding period of a year ago, and 13,460 tons in the pre-war period of 1913–14. The imports during the month of April showed an increase all round, the aggregate being 28,943 tons, as against 16,404 tons in April last year, and 6434 tons in April, 1914.

The Coal Trade.

There is nothing in the Northern coal trade to give the slightest cheerfulness to fitters in any section of the production world. The little new business circulating is so small as to attract no attention, and the lack of demand is now beginning to be felt in a more serious way than the losing of days at the pits. In the unfavourable circumstances the men employed at two collieries have been given notice to terminate their employment. Forward, the position is erratic, and while a steady level of prices is indicated it is solely maintained by the restriction of output. Best steams are obtainable at 14s. 6d., which is a firm figure. There has been a marked falling off in the demand for gas coals, and concessions are possible on recent prices. The coking coal and unscreened bunker coal trade is exceptionally dull. There is a moderate demand for supplies from the coaling centres, but beyond that neither the home consumption nor the ordinary shipment openings show any signs of activity. Every class is abundant. Good ordinary coking unscreened and bunker qualities are pressing on the market at low prices, but the best grades, while finding business difficult, are holding against making any discounts. The coke trade is steady. The export demand for every quality is full, and the home consumption, while considerable, is not up to production.

Coal Miners' Wages.

Miners' wages in Northumberland and Durham have again been saved by the minimum clause in their agreements. The accountants' report for March of the proceeds and costs in the mining industry in Northumberland shows that the wages for May would, but for the minimum clause, be at the low rate of 54·46 per cent. As this, however, is less than the percentage under the agreement, namely, 80 per cent., the latter higher percentage will continue to operate during the month. The ascertained economic percentage compares with 69·24 per cent. for the preceding month, or a reduction for the four weeks of 14·78 per cent. In Durham, but for the operation of the minimum clause in the district agreement, the rate of wages would have been 64·82 per cent. on basis rates, which compares with 65·46 per cent. in April. There is thus a small reduction. As the minimum percentage on basis rates in the county is 98, that rate will be paid to the miners, the owners having to make up 24·18 per cent.

SCOTLAND.

(From our own Correspondent.)

Clyde Shipbuilding.

THE returns for April may not be up to the average for that month, but, nevertheless, they indicate progress, and the probability of early expansion, as presumably the output might have been larger had the necessary materials come to hand in requisite quantities. The average pre-war total for the month of April was between 40,000 and 50,000 tons. A considerable number of shipyard workers and engine shopmen are still unemployed, but a fair proportion of the tonnage on the stocks is yet in the early constructional stages, while many vessels remain still to be laid down. Small tonnage figured largely in the returns for the month of April, the list including only four vessels over 4000 tons each:—Cheshire, twin-screw motor ship, 10,500 tons, built at Fairfield for the Bibby Steamship Company, Ltd., Liverpool; Chagres, passenger and cargo, 5410 tons, built at Linthouse for Elders and Fyffes, Ltd., London; Kensington Court, cargo, 4800 tons, for Halden and Co., Ltd., London; and Nikola Pasic, cargo, 4753 tons, for Messrs. Dubrovacka Parobrodska Plovidba, Glubrovnik. New contracts announced during April included the following:—Messrs. Alex. Stephen and Sons, Linthouse, to build a turbo-electric liner of 19,000 tons gross for the P. and O. Steam Navigation Company, and a cargo vessel of 5070 tons for Messrs. J. and T. Harrison, Liverpool, to be built by Charles Connell and Co., Ltd., Scotstoun.

Steel.

The outlook in the steel trade has not changed materially since last week. Producers of shipbuilding materials are pressed for deliveries, but new business is very light. Makers believe, however, that consumers have still a considerable number of orders to place, and that the latter hope to secure lower prices when the producing works slow down somewhat. The work on hand at present will, however, probably provide employment for some months ahead, and consumers may be forced to buy. Considerable quantities of foreign materials are being utilised in this district, and these might be augmented if specified deliveries could always be relied on.

Steel Sheets.

Sheet makers have struck a quieter patch, and it would seem at present as though the policy of buyers in holding off for easier terms may meet with a measure of success. It is said that some makers of the lower grade qualities of black and galvanised sheets have already booked orders for abroad at a reduction of 5s. per ton on recent prices. Quotations for the home trade are firm, however, as also are prices for the better qualities for export.

Iron.

A number of works usually engaged in the bar iron trade have not been reopened since the strike last year, and those now in operation are far from busy. The same applies to the re-rolled steel departments. Crown quality bar iron is unchanged at £11 5s. per ton, home delivery, but re-rolled steel is now quoted £8 2s. 6d. per ton, showing a reduction of 7s. 6d. per ton.

Pig Iron.

There are now thirty-five furnaces in operation in Scotland, eighteen of which are producing foundry, fourteen hematite, and three basic qualities. Hematite has a good outlet, and supplies would be scarcer if they were not augmented by imports of continental basic. The latter is presently quoted at 75s. per ton delivered at works in this district. Foundry qualities are in ample supply.

Coal.

The Scottish coal market continues in a state of depression, and in most areas work is confined to two to three days per week. Generally speaking, home demands are far below normal. Stocks of American fuels held by gas and electricity undertakings are now greatly reduced, and the local demand may improve accordingly, but there is little prospect of improvement otherwise in the meantime. Exporters continue to find business extremely difficult, owing to keen foreign competition, apart altogether from the competition from North of England fuels. Prices have an appearance of firmness, but that is due almost entirely to reduced outputs. Aggregate shipments amounted to 272,883 tons, against 236,397 tons in the preceding week and 252,548 tons in the same week last year.

A Coal Selling Agency.

Business has become so poor that a selling agency has been spoken of, the suggestion implying a central agency or a separate agency for the various districts. It is possible this matter may be discussed by the Scottish Association in the first place or by the various bodies comprising the Association.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THERE was a slight improvement in coal shipments from this district last week as compared with the previous week. The total was nearly 440,000 tons, but it is questionable whether that quantity will be maintained, for the reason that tonnage is not coming along as freely as is desired, and it is doubtful whether the demand is quite as active. Furthermore, there was no work in the coalfield on Monday on account of the May Day demonstrations which took place. These demonstrations passed off quietly. The loss of one day's output has, of course, prejudiced loading operations, but, quite apart from that, the conditions in the coal trade generally give the appearance of being quieter. Certainly there is not the usual amount of business being done for current shipment, and the demand from France and Italy, in particular, is slack. At the same time, it is refreshing to see the confidence which is displayed in the future. Last week-end, when speaking at the annual dinner at Cardiff of the South Wales branch of the Colliery Managers' Association, Mr. John Kane, who is one of the leading colliery managers and engineers in this district, is reported as having stated that the steady progress they were making in the coal trade was certainly heading for a boom. Many of those who are connected with the commercial side of the industry and have to find a market for hundreds of thousands of tons annually will, in all probability, not go so far as to say that they see any real sign of such a desirable development as that at present. An outlet can, of course, be found at a price for the coals that are being produced, but it is questionable whether the price is such as to enable the working of collieries to be really remunerative.

Coal Contract Business.

While the current demand is very limited, there have been a few inquiries for coals for delivery over a period. The Portuguese State Railways have bought about 10,000 tons for early loading, and the French Marine has asked for tenders for 98,000 tons of steam coals for delivery over about the next six months. There is no doubt that the competition for this order will be extremely keen—so keen, in fact, as to make the business scarcely worth while. Tenders had to be in on the 5th inst. The Egyptian State Railways' inquiry for 100,000 metric tons of Welsh large coals has to be decided. The prices which were sent in by the various competing firms were awaited with considerable interest on the market, as affording some indication of the views held as to the prospects of business over the next three months, during which period the quantity of 100,000 tons has to be delivered at Alexandria. The tenders for the business were opened at Cairo on Tuesday, and the news has come to hand that the lowest price is that of Evans and Reid, Ltd., of Cardiff, of 32s. c.i.f. Alexandria, for 50,000 tons, while the next figure is 32s. 3d. c.i.f., offered by Furness, Withy and Co., Ltd. Other offers range up to 34s. 6d. The business has not been placed, it being customary for the tenders to remain firm for ten days, during which period the decision of the Administration may be made known. The last time that these railways purchased, viz., in March last, the price was 33s. 5d. per ton c.i.f., while the previous contract placed in January was at the price of 31s. 11d. per ton c.i.f.

Blast-furnace Record.

Last week a flag was hoisted at the Cardiff Dowlais Works of Guest, Keen and Nettlefolds, Ltd., in celebration of the fact that all records of pig iron production for Great Britain had been broken by a new furnace. The output was over 3400 tons, which, it is stated, beats any blast-furnace record in Britain. For the previous eight weeks the average output was over 3000 tons. The manager of the works, Mr. W. Simons, has been engaged for some time in improving and extending the plant and equipment at these works, and this new furnace, which was constructed under his direction, is described as being the most up to date and efficient in the country. The view is held that the furnace is capable of even a greater output.

New Tonnage.

Reference has been made on a previous occasion to the confidence with which local shipowners view the future, as is shown by the amount of new tonnage which has been ordered during the past few months. The total has now been added to, as Sir W. R. Smith and Sons, Ltd., who control the largest fleet in South Wales, have placed an order for two steamers, each of about 8600 tons deadweight, to be built on the North-East Coast. These steamers are to be constructed to burn coal or oil fuel. Eight local firms have now altogether twenty-five steamers on order with a total deadweight of close upon 196,500 tons.

Current Business.

Although there is a lull in operations in steam coals, the market has not appreciably altered. It is possibly easier for some descriptions of the inferior class, but the leading Admiralty large and Monmouthshire qualities are fairly steady. The market, however, presents no particular feature, except in the pitwood department, although patent fuel is well sold for the next month. Pitwood, which last week went down to about 31s. to 32s., has since started on the upward grade, owing to the scarcity of prompt supplies, and prices are now round about 36s. 6d. to 37s. 6d.

CONTRACTS.

ON Saturday, April 30th, wireless services between Lisbon and the Portuguese Colonies of Cape Verde, Angola and Mozambique were put into operation. The opening of these services completes the network of wireless communication which Marconi's Wireless Telegraph Company, Ltd., undertook to construct for the Portuguese Marconi Company in accordance with the concession obtained from the Portuguese Government in November, 1922.

JAMES GORDON AND CO., Ltd., of 83, Kingsway, London, W.C. 2, have received from the Ross-shire Electric Supply Company, Ltd., through its consulting engineers, Messrs. Murdoch Macdonald and Partners, an order to supply and erect the pipes, water turbines and electrical plant required for the station at the outlet of Loch Luichart. The plant as at present designed covers the installation of two 750 horse-power Francis turbines working under a head of 110ft. and running at 600 revolutions per minute, coupled to two 500-kilowatt generators, together with switchgear, transformers, &c., and some 40 miles of transmission lines.

A SMALL AUTOMATIC STEAM ENGINE.—In our issue of April 8th we described a small automatic steam engine of German origin. We are now informed that the address of the makers given in the original article from which our translation was made was not the correct one. These small engines are made by the Resonanz-Dampfmotor G.m.b.H., of Sulzbach (Oberpfalz), Germany.

ROYAL INSTITUTION.—The annual meeting of the members of the Royal Institution was held on Monday afternoon, May 2nd, Sir Arthur Keith, treasurer and vice-president, in the chair. The annual report of the Committee of Visitors for the year 1926, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The report of the Davy Faraday Research Laboratory Committee was also read. It was reported that sixty-four new members were elected in 1926, and that seventy-eight lectures and nineteen evening discourses were delivered. The books and pamphlets presented amounted to about 229 volumes, making, with the 569 volumes—including periodicals bound—purchased by the Managers, a total of 798 volumes added to the library in the year. Thanks were voted to the president, treasurer and secretary, to the committees of managers and visitors, and to the professors, for their services to the Institution during the past year. The following were unanimously elected as officers for the ensuing year:—President, the Duke of Northumberland; treasurer, Sir Arthur Keith; secretary, Sir Robert Robertson; managers, Sir John Biles, Sidney G. Brown, Sir James Crichton-Browne, J. Mitchell Bruce, Sir Dugald Clerk, W. H. Eccles, Viscount Falmouth, J. S. Highfield, W. E. Lawson Johnston, Sir Henry Lyons, Charles H. Merz, Sir Ernest Moon, the Hon. Sir Charles Parsons, William Stone, and Sir Almroth Wright; visitors, James H. Batty, F. H. Berryman, W. A. F. Balfour Browne, Alfred Carpmael, W. Vaux Graham, Kenneth R. Hay, Sir Lawrence Jones, William Macnab, C. C. Paterson, R. W. Paul, A. O. Rankine, H. Munro Ross, W. S. Rowntree, Sidney Skinner, and F. Coston Taylor.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/–
(1) Spanish	18/6 to 21/–
(1) N. African	18/6 to 21/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	22/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 5 0 to 4 7 6	
No. 1 Foundry	4 9 0	—
No. 3 Foundry	4 4 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 2 0	4 2 0
No. 1	4 2 6	4 2 6
Cleveland—		
No. 1	3 17 6	3 17 6
Silicious Iron	3 17 6	3 17 6
No. 3 G.M.B.	3 15 0	3 15 0
No. 4 Foundry	3 14 0	3 14 0
No. 4 Forge	3 13 6	3 13 6
Mottled	3 13 0	3 13 0
White	3 13 0	3 13 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 12 6	—
,, ,, Foundry	4 1 6	—
(3) Northampton—		
Foundry No. 3	3 18 0 to 3 19 0	
Foundry Forge	3 9 0	—
(3) Derbyshire—		
No. 3 Foundry	4 0 0	—
Forge	3 12 6	—
(3) Lincolnshire—		
No. 3 Foundry	4 0 0	—
No. 4 Forge	—	—
Basic	3 17 6	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 15 6 (a); 4 18 6 (b); 5 2 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 5 0	—
Best	—	—
N.E. Coast—		
Iron Rivets	12 15 0	—
Common Bars	11 15 0	—
Best Bars	12 5 0	—
Lancs.—		
Crown Bars	11 0 0	—
Second Quality Bars	10 0 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	11 15 0	—
Best Bars	12 5 0	—
Hoops	14 0 0	—
Midlands—		
Crown Bars	11 5 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 5 0	—
Gas Tube Strip	12 10 0 to 12 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	11 0 0
Ship Plates, ½in. and up	8 7 6	£8 0 0 to 8 5 0
Sections	7 17 6	£7 10 0 to 7 15 0
Steel Sheets, under 3/16 in. to ½in.	10 0 0 to 12 0 0	
Sheets (Gal. Cor. 24 B.G.)	—	£15 0 0 to 16 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 10 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	
Billets	8 0 0 to 11 10 0	
Manchester—		
Bars (Round)	9 0 0	—
,, (Small Round)	8 5 0	—
Hoops (Baling)	11 0 0	11 0 0
,, (Soft Steel)	10 15 0	10 15 0
Plates	8 7 6	—
,, (Lancs. Boiler)	11 7 6	—
Sheffield—		
Siemens Acid Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	7 5 0 to 7 10 0	
Hoops	12 0 0	—
Soft Wire Rods	9 5 0	—
Midlands—		
Small Rolled Bars	8 10 0 to 8 15 0	
Billets and Sheet Bars	7 0 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	14 10 0 to 15 0 0	
Angles	7 15 0 to 8 0 0	
Joists	7 15 0 to 8 0 0	
Tees	8 15 0 to 9 0 0	
Bridge and Tank Plates	6 7 6	—
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/3 to 19/6
Block Tin (cash)	297 0 0
,, (three months)	288 15 0
Copper (cash)	54 7 6
,, (three months)	55 0 0
Spanish Lead (cash)	25 15 0
,, (three months)	26 6 3
Spelter (cash)	29 2 6
,, (three months)	29 10 0
Manchester—	
Copper, Best Selected Ingots	60 10 0
,, Electrolytic	61 12 6
,, Strong Sheets	86 0 0
,, Tubes (Basis Price) lb.	0 1 0½
Brass Tubes (Basis Price) lb.	0 0 11½
,, Condenser lb.	0 1 1½
Lead, English	27 5 0
,, Foreign	26 5 0
Spelter	29 10 0
Aluminium (per ton)	£107

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/5½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 10 0	7/3
,, ,, 8 p.c. to 10 p.c. ,,	£22 7 6	6/6
,, ,, Specially Refined		
,, ,,Max. 2 p.c. carbon	£36 6	11/6
,, ,, ,, 1 p.c. ,,	£42 5 0	15/–
,, ,, ,, 0.70 p.c. carbon	£54 0 0	17/6
,, ,, ,, carbon free	1/5d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£16 for home, £16 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 17 6 per unit	scale 5/– per
,, ,, 75 p.c.	£19 0 0 per unit	scale 6/– per
,, Vanadium	14/3 per lb.	
,, Molybdenum	5/– per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	9/3 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/6
,, ,, Ell	14/9
,, ,, Splint	15/6 to 16/9
,, ,, Trebles	14/– to 14/3
,, ,, Doubles	13/– to 13/6
,, ,, Singles	13/– to 13/3
Ayrshire—	
(f.o.b. Ports)—Steam	14/–
,, ,, Jewel	16/–
,, ,, Trebles	14/–
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/9 to 14/–
Screened Navigation	21/–
Trebles	14/6
Doubles	13/6
Singles	13/–
Lothians—	
(f.o.b. Leith)—Best Steam	14/–
Secondary Steam	13/– to 13/3
Trebles	14/6
Doubles	13/3 to 13/6
Singles	13/–

ENGLAND.

	Inland.
(8) N.W. Coast—	
Steams	27/6
Household	42/6 to 58/6
Coke	28/6 to 30/–
Northumberland—	
Best Steams	14/3 to 14/6
Second Steams	14/–
Steam Smalls	10/6
Unscreened	13/6 to 14/–
Household	21/– to 27/–
Durham—	
Best Gas	17/– to 17/6
Second	14/9 to 15/3
Household	21/– to 27/–
Foundry Coke	24/6 to 26/6
Sheffield—	
Best Hand-picked Branch	32/– to 34/–
Best Selected House Coal	27/– to 29/– —
Screened House Coal	23/– to 25/– —
,, ,, Nuts	19/– to 21/– —
Yorkshire Hards	18/– to 20/– —
Derbyshire Hards	18/– to 20/– —
Rough Slacks	10/6 to 11/6 —
Nutty Slacks	9/– to 9/– —
Smalls	3/– to 5/6 —
Blast-furnace Coke (Inland)	22/– to 27/6 at ovens.*
,, ,, (Export)	f.o.b. 26/– to 27/–

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	22/9 to 23/6
Second ,, ,,	21/6 to 22/6
Best Dry Large	21/– to 21/6
Ordinary Dry Large	19/6 to 20/6
Best Black Vein Large	21/6 to 22/–
Western Valley Large	20/– to 21/–
Best Eastern Valley Large	19/6 to 20/6
Ordinary ,, ,,	19/– to 20/–
Best Steam Smalls	14/– to 14/6
Ordinary Smalls	12/– to 14/–
Washed Nuts	18/– to 22/–
No. 3 Rhondda Large	23/– to 24/–
,, ,, Smalls	16/6 to 17/–
No. 2 ,, Large	20/– to 21/–
,, ,, Through	18/– to 19/–
,, ,, Smalls	13/– to 14/–
Foundry Coke (export)	40/– to 45/–
Furnace Coke (export)	30/– to 32/6
Patent Fuel	25/9 to 26/6
Pitwood (ex ship)	36/6 to 37/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	37/6 to 42/6
Seconds	31/– to 34/–
Red Vein	27/– to 29/6
Machine-made Cobbles	45/– to 50/–
Nuts	45/– to 47/6
Beans	35/– to 38/–
Peas	20/– to 22/–
Breaker Duff	9/– to 9/6
Rubbly Culm	11/9 to 12/3
Steam Coals:	
Large	21/– to 22/–
Seconds	19/6 to 21/–
Smalls	11/6 to 12/6
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/– extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. * Open market price. Special price for pig iron producers, 22/– per ton at ovens.

French Engineering Notes.

(From our Correspondent in Paris.)

Colonial Works.

THE plans that have been prepared for the carrying out of public works at home and in the Colonies would provide full employment to engineering firms if it were possible to procure the money for their execution. There has rarely been so much activity in the way of public works schemes, and so far as the home proposals are concerned, many of them will probably be held in abeyance for a considerable time unless assistance can be obtained from Germany on account of reparations. Germany, however, is showing great reluctance to supply material for any undertaking that aims exclusively at increasing the economical development of France. The same activity is observable in the Colonies, where the construction of harbours, railways and other works is to be carried out on an extensive scale if only Germany can be induced to contribute material under the Dawes agreement. It is not intended that the importations from Germany shall diminish industrial activity at home. Whatever is taken from that country will be in the form of parts and accessories that will bear no indication of their origin, and railway rolling stock and other material will be completed and assembled in French shops. It is also expected that German participation will be secured to allow of the Trans-Saharan Railway being put in hand. Contracts are said to be in preparation with the Paris, Lyons and Mediterranean Railway Company for the construction of the line, which would be completed in a minimum period of seven years at an estimated cost of 800 million francs for the track and rolling stock alone. As a matter of fact, it is impossible to say what the Trans-Saharan Railway will cost, for the line has not even been surveyed, and the total cost will certainly be enormous in view of the proposal to lay down water mains right across the desert.

Sales Organisations.

Negotiations continue to be carried out for the creation of a sales organisation for girders, and although it is hoped that something will come out of the meeting at Luxembourg this week, it is doubtful whether an agreement will be reached on account of the claims of the French and Belgian rolling mills. It was proposed that each country should have the same quota as for raw steel under the terms of the Steel Cartel, and it is difficult to see how any other arrangement is possible; but girder makers in France and Belgium insist on having an increase of 10 per cent. on the quota, as fixed by the production during the first quarter of 1926, on the ground that the rolling mills were not working to their full capacity, the Belgian output being restricted by the effects of the previous strike; while French makers declare that some of the mills were not at the time completely reconstructed. As Germany is absolutely opposed to this increase, some sort of compromise will have to be come to, and it is expected that a settlement will be arrived at eventually, on account of the necessity of doing something to prevent the girder trade from becoming entirely disorganised. While the Steel Cartel limits the production of raw steel the sales offices are intended to attain the same end by dividing up the business in rolled iron and steel according to each country's productive capacity.

Tunnelling the Vosges.

The connecting up of Alsace with the Est railway system by a number of tunnels through the Vosges is regarded as necessary for the prosperity and security of the province, and although some of the schemes are likely to be held up indefinitely on the ground that the services rendered by the tunnels do not appear to justify the cost of construction, two at least may be put in hand at an early date. Arrangements are now being made to prepare a Bill for introduction into the Chamber of Deputies ddclaring the tunnels between Saint Dié and Sainte Marie-aux-Mines and between Cornimont and Metzeral undertakings of "public interest." The communes, Chambers of Commerce and other bodies, which will benefit from the construction of the tunnels, will be required to contribute to the cost, and the carrying out of the work will depend upon the extent of this contribution. A good deal of the financial burden will also devolve upon the Compagnie de l'Est.

Inland Navigation.

The amount of traffic on the inland waterways during 1926 was 39,068,760 tons, as compared with 37,130,761 tons in the previous year. The increase was particularly noteworthy on the Rhine, where the traffic improved by nearly 45 per cent. On the northern canals the coal traffic is steadily developing as the result of the electrification which permits of an acceleration by electric haulage.

Wages Reductions.

The situation of the iron and steel trades continues unchanged, except for a slight improvement in demand which is observable in some cases, and that a general belief that the worst is past has revived confidence in the future. Nevertheless, it is clear that prices which were forced up by the depreciation of the franc are too high, and as consumers will not pay them, efforts are being made to effect economies in production in every possible way. Wages must be reduced, and they are being reduced appreciably in all cases when men are being taken on, but it is not being done without trouble, as was evidenced by the agitation amongst the 30,000 men in the Citroën factories. In the Saar an arbitration judgment reduced wages 10 per cent., whereupon the men employed in fourteen factories went out on strike, and the Employers' Association, comprising fifty-four factories, has announced that if the men do not return all the works will be closed. The situation of the Saar firms is particularly difficult, as they can only export a certain quantity of iron and steel to Germany, and France is quite incapable of absorbing the remainder of the production.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

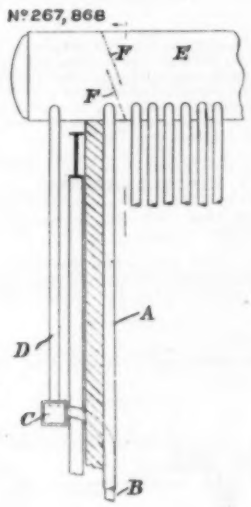
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

267,868. January 14th, 1927.—WATER-TUBE BOILERS, The Stirling Boiler Company, 32, Farringdon-street, London, E.C. 4; and H. J. S. Mackay, 6, Charles-street, St. James's-square, London, S.W. 1.

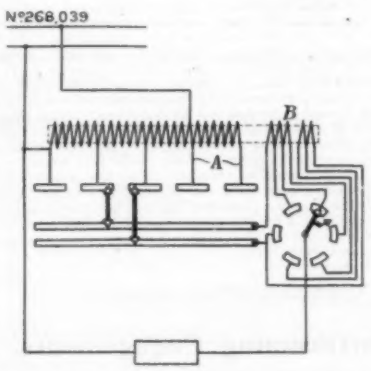
It is suggested in this specification that, when a water screen is used around the fire-box of a boiler fired with powdered fuel, the ebullition in the tubes of the screen is so violent that it produces frothing in the steam drums with which they are connected. In the boiler under review the water screen tubes are shown at A and B, those marked B being connected with a header C from which occasional risers D go to the main steam drum. It will be noticed that both the tubes A and the risers D go into the steam drum towards its extreme end and that, between that part and the main steam collecting section, E there is a set of baffles F F to prevent the violent discharge of the screen tubes from interfering with the circulation through the main steam raising tubes of the boiler.—*March 24th*, 1927.



TRANSFORMERS AND CONVERTERS.

268,039. December 24th, 1925.—IMPROVEMENTS IN ELECTRIC TRANSFORMERS REGULATABLE BY VARYING THE ACTIVE NUMBER OF COILS, Ewald Hering, of Herzog Rudolfstrasse 51, Munich, Germany.

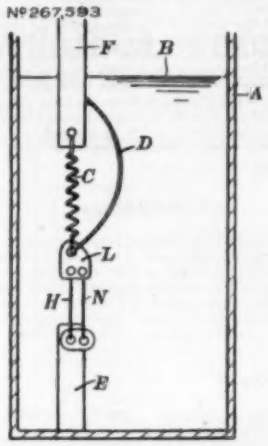
The transformer described in this specification comprises a winding divided by tappings A into sections, which can be rendered active and inactive in succession, for regulating the voltage by coarse steps. There are also two electrically separate coil systems B, subdivided by tappings, for regulating the voltage by smaller steps, with a switch arm and contacts for cutting the subdivided systems into circuit alternatively, so that for continuous variation of voltage, the dead subdivided system can be connected to the next coarse coil tapping in order of succession.—*March 24th*, 1927.



SWITCHGEAR.

267,593. December 16th, 1925.—IMPROVEMENTS IN OR RELATING TO ELECTRIC FUSIBLE CUT-OUTS, William Herbert Isherwood, of 4, Caythorpe-road, Leeds; and Reginald Thomas Norton, of Temple Courts, Temple-row, Birmingham.

This invention relates to electric fusible cut-outs and particularly to those that are immersed in liquid in a suitable container and in which the opening of the circuit when fusion occurs is accelerated by a spring or springs. By reason of the cooling effect of the liquid on an immersed fuse, the rating of the fuse is very high, or, in other words, the fuse is very slender and mechanically weak. A slender fuse is liable to elongate under the pull of the spring, its mechanical strength and its fusing current being thus reduced, so that it becomes unreliable. The invention relates to a fusible cut-out in which these defects are obviated by relieving the fuse wholly or in part of the pull of the spring. A is a vessel filled with liquid to the level B, and containing a fuse H stretched between a fixed terminal E and a part L by a spring C attached at one end to the terminal F and at the other to the part L. Current may be conveyed to the fuse by a flexible connection D, so that the spring C has not to carry current and is not liable to deterioration through heating.

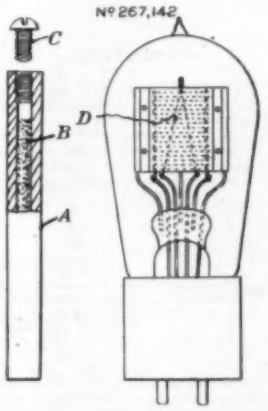


A thread N is also stretched between the parts L and E to which the fuse H is attached. The thread is of such a length as normally to take the pull of the spring C, and it is so constructed and disposed as to be destroyed, disconnected, or released when the fuse melts, thus permitting the spring C to operate.—*March 16th*, 1927.

TELEGRAPHS AND TELEPHONES.

267,142. March 4th, 1927.—IMPROVEMENTS IN THERMIONIC ELECTRODES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

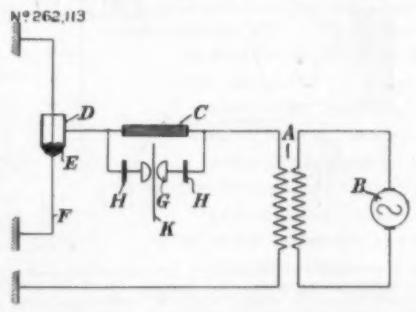
This invention has particular reference to electrodes on which, during operation, there is formed an adsorbed thin film of material, which is capable of stable operation at a temperature so high that under other conditions the material would be immediately vaporised. In the preparation of an electrode according to the invention a tubular body A, preferably closed at one end, is provided with a charge B of active material. The tubular holder may consist of iron, nickel, or similar metal. The charge of active material with which the tube is filled may consist of a metal of lower electron affinity which is capable of diffusing through the walls of the finished article as, for example, metallic caesium, rubidium, barium, calcium, thorium, cerium, or a related metal or of a mixture of these metals. Alternatively, the tube may contain a mixture of a compound of the desired metal and a reducing agent which is capable, at the operating temperature of the electrode, of setting free the desired metal or metals, without forming deleterious by-products. For example, the tube may be filled with a mixture of caesium chloride and magnesium or calcium powder. The metal tube, when filled with the desired core material and closed by the insertion of the screw C, is swaged in the well-known manner to a diameter small enough either to permit use of the wire directly in suitable lengths or to permit of further reduction by drawing through dies. A wire containing a core material, as described above, is mounted as a cathode D in an evacuated envelope which also contains an anode and a grid (indicated by dotted lines).—*March 21st*, 1927.



MEASURING AND TESTING INSTRUMENTS.

262,113. November 24th, 1926.—MEANS FOR REGISTERING FAULTS OF INSULATION IN INSULATED ELECTRIC CONDUCTORS, Allgemeine Elektricitäts, Gesellschaft, of 2–4, Friedrich Karl-Ufer, Berlin, N.W. 40, Germany.

For registering faults of insulation in insulated electric conductors in accordance with this invention a transformer A is connected to a source B of alternating current, one pole of the transformer being earthed whilst the other is connected through

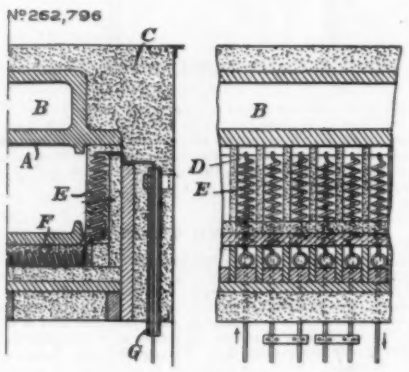


an impedance C to the testing apparatus, which consists of a metal vessel D containing small balls E. The conductor F to be tested is drawn through these balls and has its ends earthed. A spark gap is provided at G between the condensers H, connected across the resistance as shown. Upon a faulty part of the insulation passing through the testing apparatus, contact is made between the conductor F and container D through the balls and the transformer circuit is completed. A difference in voltage is produced at the poles of the resistance by the short circuit. The voltage necessary for passing current through the resistance must be greater than that needed for actuating the spark gap in order that there may be an equalisation of voltage across the gap. The disruptive sparks strike through the paper strip, which moves forward at a speed proportional to that of the length of the wire F that is unwound, and if a suitable scale be applied to the paper strip it is possible to indicate the faults in the insulation with reference to the length of wire.—*March 31st*, 1927.

FURNACES.

262,796. December 9th, 1926.—Improvements in or relating to Electric Furnaces, *International General Electric Company, Incorporated, of* 120, *Broadway, New York.*

The heating elements of the electric furnace described in this specification are freely suspended in the heating chambers so that they can easily be changed. The heating chamber is closed above by a removable cover A in which a preheating chamber B

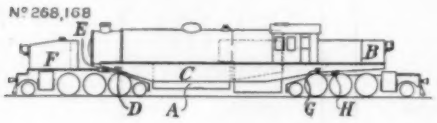


is formed, and the two chambers are surrounded by a granulated insulating filling mass C. The floor and the sides of the heating chamber are provided with fireproof insulating plates which form the passages D, that serve for the changeable heating windings E, which are freely suspended perpendicularly. There are other heating bodies, arranged horizontally as shown at F. For carrying the leads porcelain tubes G are provided.—*March 24th*, 1927.

LOCOMOTIVES.

268,168. May 17th, 1926.—Improvements in Locomotives, *Reginald Haddan, of Herbert Haddan and Co., of* 31 *and* 32, *Bedford-street, Strand, London, W.C.* 2.

The invention relates to locomotives having two separately driven bogies, one supporting the main frame only and the other supporting the main frame and a storage container. The object of this invention is to reduce the overall length of a locomotive,

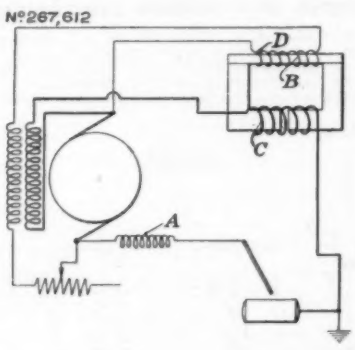


with a boiler of given length, and by the same means to obtain a low centre of gravity. The boiler, cab, lower tank A and the bunker with another rear tank B if required, form a rigid structure with the main frame C, which is connected by a pivot D with the forward bogie and rests upon it by means of studs E working in grooves or slots. The forward bogie carries a tank F. The frame C is connected to the rear bogie by means of a pivot G and rests thereon by means of studs H.—*March 31st*, 1927.

MACHINE TOOLS AND SHOP APPLIANCES.

267,612. December 18th, 1925.—Improvements in and relating to Current Generating and Controlling Appliances particularly Applicable for Use in Electric Arc Welding, The Quasi-Arc Company, Ltd., and Arthur Percy Strohmenger, both of 15, Grosvenor-gardens, London, S.W. 1.

The generator armature supplying the welding current

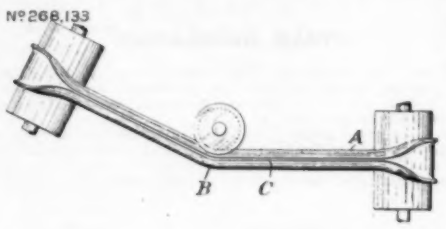


rotates in a magnetic field produced by a shunt winding and a series winding which opposes the former. Interpoles are provided, each carrying a series winding A. The main poles are normally fairly saturated. A reactor B connected as shown consists of a laminated iron core provided with one or more air gaps. The primary winding C is in series with the load circuit, whilst the winding D is in series with the shunt circuit, and the connections are such that the magnetic field of this winding opposes that produced by the winding C. The limb on which the winding D is wound is normally highly saturated.—*March 18th*, 1927.

CRANES AND CONVEYORS.

268,133. March 29th, 1926.—Improvements in or relating to Endless Conveyors, Christian Hamilton Gray, of the India Rubber, Gutta Percha and Telegraph Works Company, Ltd., of 106, Cannon-street, London, E.C. 4.

In addition to its ability to follow a deflected path, the conveyor belt described in this specification protects the material

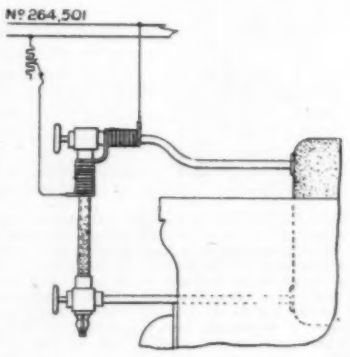


that is being conveyed. The conveyor shown lies in two different vertical planes and comprises an endless belt A passing over rollers as shown, the path of the belt being deflected at B by means of a grooved pulley. The belt is of circular shape in cross section, and in its normal condition it is of tubular form with a slit, but it flattens where it passes over the end rollers in the manner indicated.—*March 31st*, 1927.

MISCELLANEOUS.

264,501. January 12th, 1927.—Gauge Glasses, *The British Thomson-Houston Company, Crown House, Aldwych, London, W.C.* 2.

It is explained in this specification that in the case of high-pressure boilers there is a tendency for glass gauges to be corroded away by water which may condense in the space above the water



level in the glass. In order to overcome this trouble the inventors propose to maintain the steam in the glass above the water level in a superheated state by means of external heat, such as that supplied electrically as shown in the illustration. It is claimed that in the superheated condition the steam is non-corrosive.—*March 24th*, 1927.

268,225. September 21st, 1926.—Improved Copper Alloys, Metallbank und Metallurgische Gesellschaft Aktiengesellschaft, of 45, Bockenheimer Anlage, Frankfurt-on-the-Main, Germany.

This specification describes an alloy consisting of 93·8 to 78·5 per cent. copper, 5 to 9·5 per cent. aluminium, 1 to 6 per cent. manganese, 0·1 per cent. to 3 per cent. iron, and 0·1 to 3 per cent. nickel. The following example is given to show the suitability of these alloys for use as bearing metals :—With a specific load of 23·8 kilos. per square millimetre and a peripheral speed of 1·78 m. per second, the temperature of a test bearing disc of best phosphor-bronze was 49 deg. Cent., whilst that of a bearing disc of an alloy according to the present invention was only 42 deg. Cent. Owing to the absence of zinc, the alloys made in accordance with the invention are claimed to possess a considerably higher chemical stability than the zinc-containing alloys, for which reason they can be employed in the chemical industry. Their great plasticity in the hot state is said to render them suitable for the production of pressed parts of any kind which are exposed either to high temperatures or to chemical action.—*March 31st*, 1927.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Chemical Engineering Group.—Imperial College of Science and Technology, South Kensington, S.W. 7. Annual general meeting, 6 p.m. Informal dinner, 6.30 p.m. Subsequently, in the Metallurgical Lecture Theatre, Royal School of Mines, paper, "Chemical Fire Extinguishers," Dr. W. R. Ormandy, F.I.C. 8 p.m.

Institution of Structural Engineers.—10, Upper Belgrave-street, London, S.W. 1. Joint meeting with the Société des Ingénieurs Civils de France. Paper, "Engineering Features of the Channel Tunnel," by Monsieur le Trocquer. 6 p.m.

Iron and Steel Institute.—Institution of Civil Engineers, Great George-street, London, S.W. 1. Annual meeting. For programme see page 428. 10 a.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "Some Notes on the Brighton Automatic Telephone Network," by Mr. W. A. Sallis. 7.30 p.m.

Keighley Association of Engineers.—Queen's Hotel, Keighley. Annual general meeting. President's address. 8 p.m

SATURDAY, MAY 7TH.

Institute of British Foundrymen : Lancashire Branch.—College of Technology, Sackville-street, Manchester. Paper, "Some Aspects of Foundry Work," by Mr. E. Longden. 4 p.m.

Institution of Municipal and County Engineers.—Town Hall, Dover. South-Eastern District Meeting. 11 a.m.

MONDAY, MAY 9TH.

Royal Institution.—21, Albemarle-street, London, W. 1. General meeting. 5 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture, "Measurement of Light," by Mr. John W. T. Walsh. 8 p.m.

Surveyors' Institution.—12, Great George-street, Westminster, S.W. 1. Discussion, "The Practical Application of the Rating and Valuation Act, 1926." Opener, Mr. A. M. Trustram Eve. 8 p.m.

TUESDAY, MAY 10TH.

Institute of Marine Engineers.—85/88, The Minories, Tower Hill, E. 1. "Some Metals and Methods of use in Marine Engineering," by Horace J. Young, F.I.C. 6.30 p.m.

Institution of Civil Engineers.—Great George-street, Westminster, London, S.W. 1. Annual general meeting. 6 p.m.

WEDNESDAY, MAY 11TH.

Electrical Association for Women.—Hotel Cecil, Strand, London, W.C. 2. Luncheon. 1 for 1.15 p.m.

Institute of Metals.—Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W. 1. Seventeenth annual May Lecture, "The Growth of Crystals in Supersaturated Liquids," by Sir Henry A. Miers, F.R.S. 8 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Dr. Mann Lecture, "English Railways," by Professor W. E. Dalby, F.R.S. 8 p.m.

THURSDAY, MAY 12TH.

Institution of Structural Engineers.—10, Upper Belgrave-street, London, S.W. 1. Paper, "Some Problems in the Design of Steel Roof Truss Members," by Mr. A. G. Pugsley. 8 p.m.

FRIDAY, MAY 13TH.

Institution of Municipal and County Engineers.—92, Victoria-street, Westminster, S.W. 1. Metropolitan District meeting. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street S.W. 1. Final meeting of the winter session. "Stability of Dredged Cuts in Alluvium," by Herbert Chatley, D.Sc. (Eng.). 7.30 p.m.

Royal Institution.—21, Albemarle-street, London, W. 1. Discourse, "Concerning Old Age," by Sir Humphry Rolleston. 9 p.m.

SATURDAY, MAY 14TH.

Institution of Municipal and County Engineers.—Town Hall, Cleckheaton. Yorkshire District meeting. 2 p.m.

MONDAY, MAY 16TH.

Railway Club.—25, Tothill-street, London, S.W. 1. Paper, "Some Railway Byways," by Mr. C. N. Anderson. 7.30 p.m.

WEDNESDAY, MAY 18TH.

Institution of Sanitary Engineers.—Visit to the works of A. and F. Pears, Ltd., at Isleworth. 2.30 p.m.

SATURDAY, MAY 21ST.

Institute of British Foundrymen : Lancashire Branch.—Visit of the Junior Section to the works at Ashton-under-Lyne of the National Gas Engine Company, Ltd. Parties will commence to tour the works at 2.45 p.m.

THURSDAY, MAY 26TH.

Institution of Municipal and County Engineers.—Town Hall, Ilkeston. East Midland District meeting. 10.45 a.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

We are asked to announce that Mr. Treece, who has been works manager of Electricars, Ltd., Landor-street, Birmingham, for the past six years, has now been appointed general manager.

Brittain's Electric Motor Company, Ltd., of 110, Cannon-street, London, E.C. 4, asks us to announce that it has removed its offices from the fourth floor of the building to the first floor. The telephone number remains the same, namely, City 2744.

James Turnbull and Co., of 3, New-street, Birmingham, ask us to announce they have been appointed Midlands representative for Empson Centrifugals, Ltd., 47, Victoria-street, S.W. 1, for the sale of that company's machines for the recovery and purification of oils and liquids.

The Gandy Belt Manufacturing Company, Ltd., of Wheatland Works, Seacombe, Cheshire, asks us to announce that it has been decided to rebuild its works on the present site. An up-to-date fireproof building, with every modern appliance for the manufacture of all classes of machine belting, will be erected.

Marcel Porn, of 72-78, Fleet-street, London, E.C. 4, asks us to announce that his business has been converted into a private limited liability company, under the name of "Porn and Dunwoody, Ltd." The company has taken over all the business previously transacted by him, and will carry on the same under his personal supervision as managing director.

Thos. W. Ward, Ltd., of Sheffield, ask us to announce that they have :—(*a*) Purchased from the Joint Receivers and Liquidators the remaining portion of the property, formerly used as the engineering, bridge building and constructional works, of Swingler and Co., of Derby ; and (*b*) that they have also purchased from a Liverpool firm the large sugar refinery at Rawcliffe Bridge, which has been shut down for a number of years.

Research Scholarships in Technology.—The governing body of the Manchester Municipal College of Technology (University of Manchester) offers a limited number of Research Scholarships in Technology, each of a value not exceeding £100, which will be tenable during the session 1927–28 in the College. These scholarships will be awarded in July next. Research may be undertaken in any of the following departments :—(1) Mechanical engineering ; (2) electrical engineering ; (3) municipal and sanitary engineering ; (4) applied chemistry :—(*a*) general chemical technology ; (*b*) chemistry of textiles (bleaching, dyeing, printing and finishing) ; (*c*) dyestuffs ; (*d*) fuels ; (*e*) paper manufacture ; (*f*) metallurgy and assaying ; (*g*) chemical technology of brewing ; and (*h*) electro chemistry ; (5) textile industries ; (6) photographic technology ; (7) printing ; and (8) industrial administration. Applications must be received on or before July 6th, 1927. Forms of application and all information may be obtained by written application to the Registrar of the College.